July 1946

TECHNOLOGY REVIEW

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POSTWAR DESIGNS COMBINE
STRENGTH WITH LIGHTNESS
FOR GREATER EFFICIENCY!

THE HARVEY METAL CORPORATION

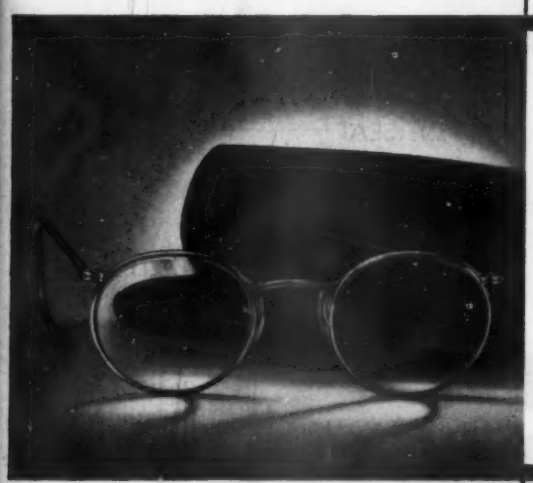
HAROLD B. HARVEY '05 • *Engineers & Manufacturers* • SHERRY O'BRIEN '17

74th STREET and ASHLAND AVENUE • CHICAGO 36, ILLINOIS

FORGINGS IN ALUMINUM • BRASS • BRONZE • COPPER • MAGNESIUM • MONEL • ALLOYS

MACHINING FACILITIES

skilled men
wear safety goggles



and they
prefer A-O metal ful-vues for
comfort and appearance

Skilled workers appreciate the comfort and good appearance of A-O Ful-vue Goggles. They provide all-angle vision and are shaped to conform to the orbit of the eye (thus, bringing the lenses closer to the face and leaving no unprotected area around the bridge of the nose). Made in three eye and three bridge sizes, with 6-curve Super Armorplate Clear or Calobar lenses—with or without side shields. Your nearest A-O Safety Representative can supply you.

A-O Safety Goggles
Safeguard the Eyes
of Industry

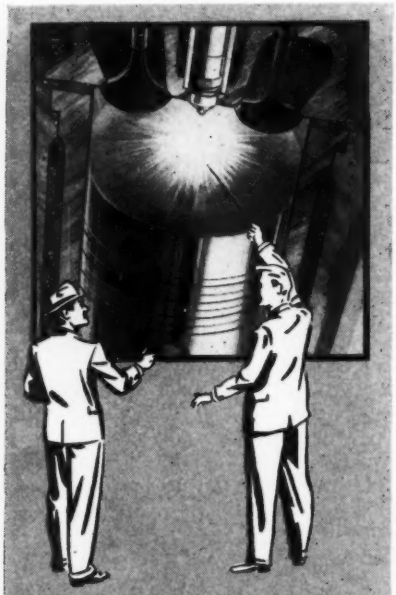
American Optical COMPANY *Safety Division*

SOUTHBRIDGE, MASSACHUSETTS
BRANCHES IN PRINCIPAL INDUSTRIAL CITIES

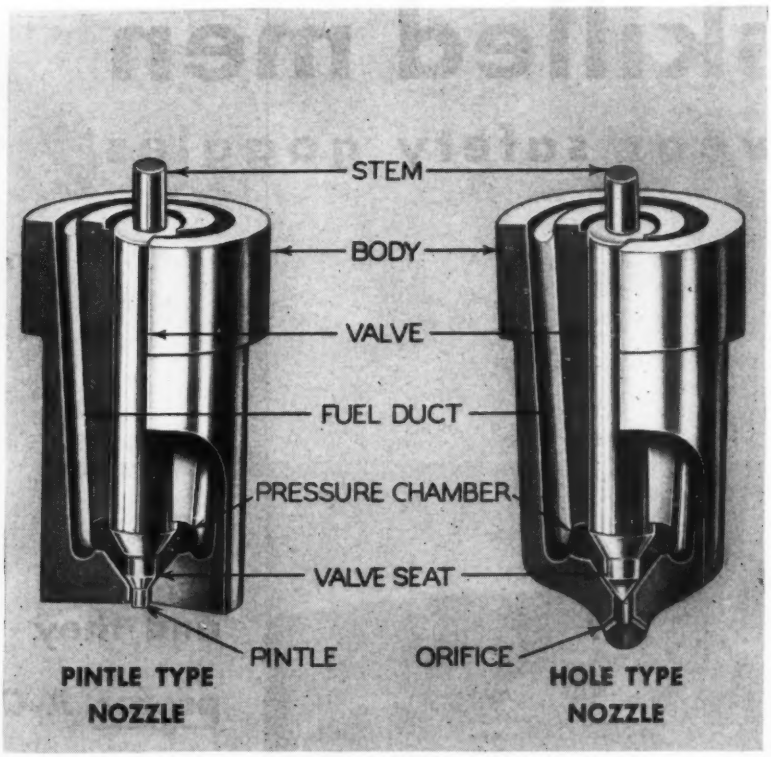
THE TECHNOLOGY REVIEW, July, 1946. Newsstand Edition. Vol. XLVIII, No. 9. Published monthly from November to July inclusive at 10 Ferry Street, Concord, N. H. Publication date: twenty-seventh of the month preceding date of issue. Annual subscription $3.50; Canadian and Foreign subscription $4.00. Entered as second-class matter at the Post Office at Concord, N. H., under the Act of March 3, 1879.

GOOD FUEL INJECTION

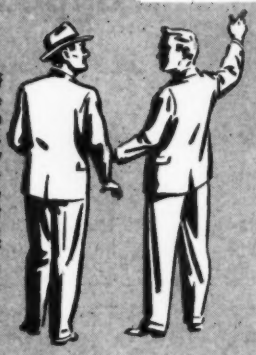
Requires a Tailored Spray

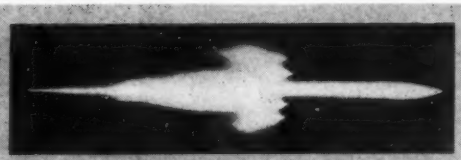


THE MAIN FUNCTION of an injection system is to deliver fuel to the engine cylinders in such a manner that it will burn efficiently. That's why the injection nozzle is so important. It must produce a spray that meets exactly the combustion-chamber requirements.



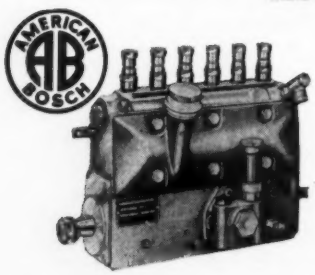
Tailoring is the art of producing the precise spray characteristic which the engine likes best. Tailoring know-how comes from long experience in correlating the selection of every part of the injection system for the single purpose of providing the engine with the ideal spray pattern.





THE CORRECT PATTERN PAYS ITS WAY. American Bosch Injection Equipment provides tailored fuel sprays to fit your Diesel's combustion chamber. That means fuel economy, power to suit the task at hand, and satisfactory performance under all operating conditions.

WRITE FOR A COMPLETE DIRECTORY OF AMERICAN BOSCH AUTHORIZED SERVICE STATIONS



AMERICAN BOSCH CORPORATION, SPRINGFIELD 7, MASS.

AMERICAN BOSCH

Diesel Fuel Injection

To do your surfacing jobs better

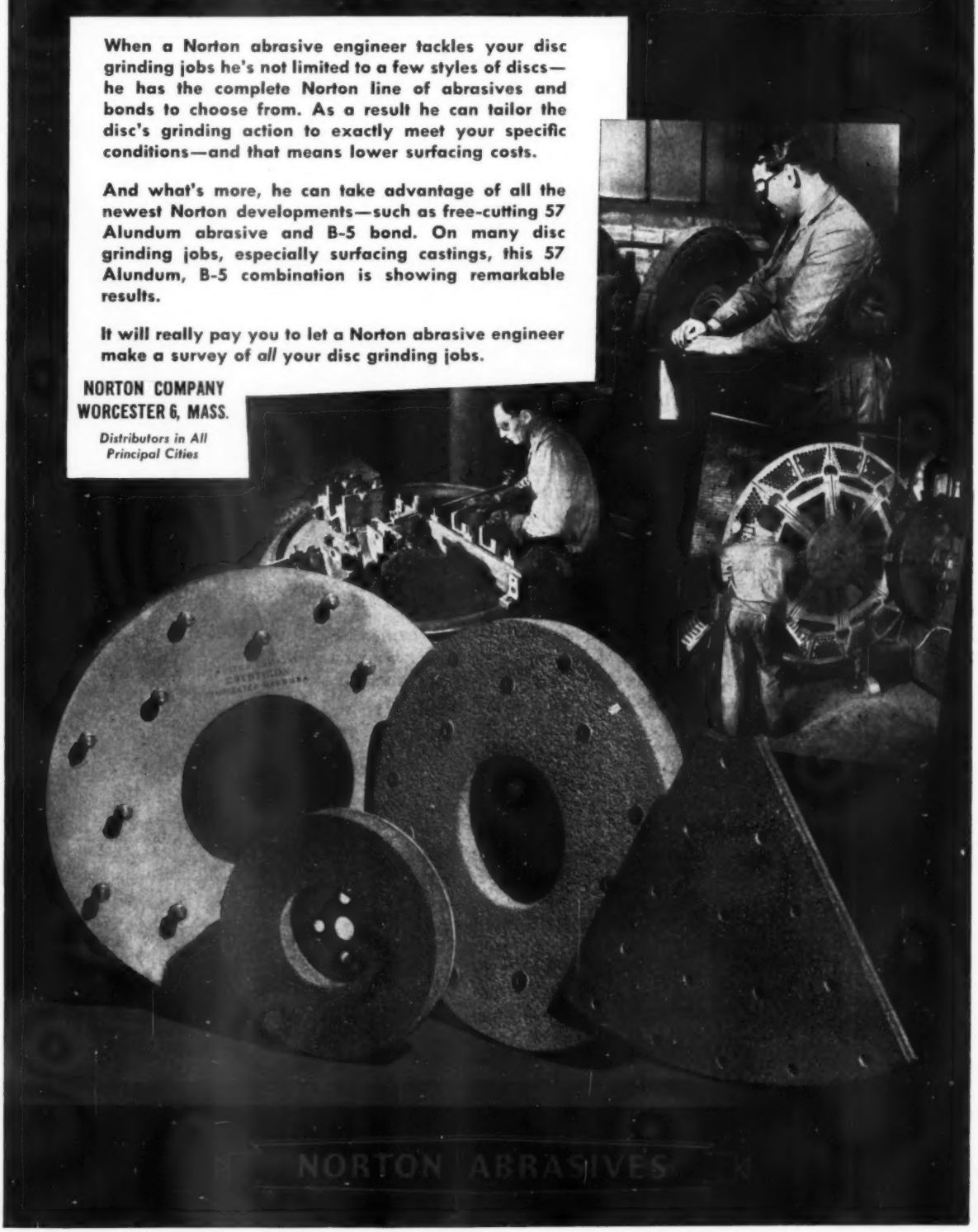
use NORTON DISC WHEELS

When a Norton abrasive engineer tackles your disc grinding jobs he's not limited to a few styles of discs—he has the complete Norton line of abrasives and bonds to choose from. As a result he can tailor the disc's grinding action to exactly meet your specific conditions—and that means lower surfacing costs.

And what's more, he can take advantage of all the newest Norton developments—such as free-cutting 57 Alundum abrasive and B-5 bond. On many disc grinding jobs, especially surfacing castings, this 57 Alundum, B-5 combination is showing remarkable results.

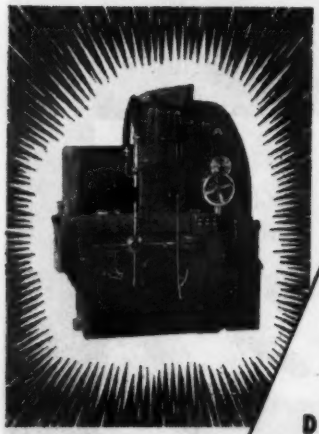
It will really pay you to let a Norton abrasive engineer make a survey of *all* your disc grinding jobs.

NORTON COMPANY
WORCESTER 6, MASS.
Distributors in All Principal Cities



IF YOU MACHINE FLAT SURFACES...

these examples of actual production should interest you!



The Blanchard No. 11 Surface Grinder

A Forty-eight cast iron pump bodies, 6 inches diameter, are ground per hour, removing .012 inch of metal to limits of +.0003 inch —.0001 inch.

B Seventy-two cast iron ball bearing spacer rings 3 inches to 5 inches diameter are ground on both ends per hour, removing .025 inch of metal from each end, to limit for parallelism of .0002 inch.

C Fifteen alloy steel plates, 24¼ inches x 5⅝ inches and $1\frac{1}{32}$ inches are ground per hour, removing .015 inch of metal from each side, then finish grinding the first side removing .010 inch of metal, a total of .040 inch from the two sides, to limits of ±.00075 inch.

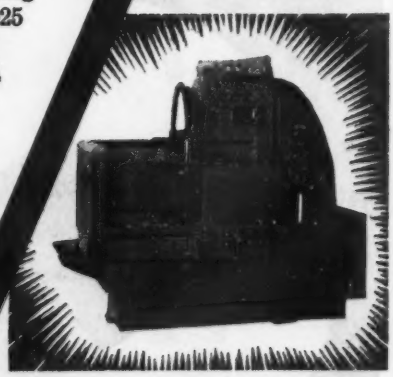
D One semi-steel swivel table for Shaper is ground in one hour and thirty-five minutes, grinding six sides, removing ⅛ inch of metal from each side. These tables are finish ground from rough castings 15½ inches x 16 inches x 16 inches to limits of ±.005 inch for dimensions and finished table must be square within .0015 inch in 16 inches.

E 150 alloy steel pump plates, 2⅜ inches x 1⅞ inches x ½ inch, are ground per hour on both sides, removing .009 inch of steel from each side, to limits of ±.00025 inch.

F 109 forged, nickel steel airplane engine cams, 10¾ inches x 8¾ inches x ⅞ inch are ground per hour on both sides, removing from .040 inch to .060 inch of metal from each side to limits of ±.001 inch.

Send for your free book of "Work Done on the Blanchard", third edition. This new book shows over 100 actual jobs where the Blanchard Principle is earning profits for Blanchard owners.

The Blanchard No. 18 Surface Grinder



IF YOU MACHINE FLAT SURFACES...

bring your problems to.

BLANCHARD

The BLANCHARD MACHINE COMPANY

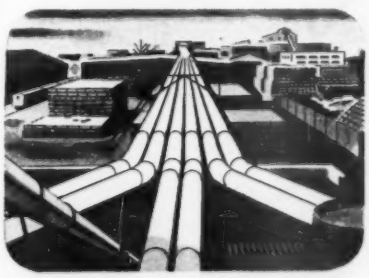
64 STATE STREET CAMBRIDGE 39, MASS. U. S. A.

NOTHING WORKS BETTER THAN AIR

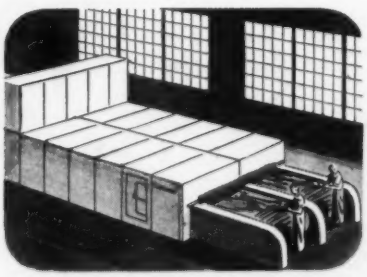
WHEN YOU HAVE PRODUCTION PROBLEMS LIKE THESE

AIR IS SUCH a common commodity that people are apt to overlook its almost limitless capacity to be put to work. Yet there is scarcely an industry today in which air—properly engineered—cannot help to cut costs, improve production, save on man-hours, materials and machines.

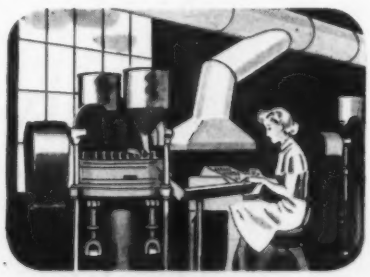
In hundreds of plants, Sturtevant "engineered air" is used in conveying raw materials . . . stepping up the efficiency of power plant combustion . . . controlling dust and fumes . . . drying textiles and cooling glass furnaces. And it handles these jobs better, more economically, than any other means. To give you just a few examples—



1. Ten thousand pounds of cork per hour—cleaned and then whisked more than a quarter of a mile from processing building to storage bins. Imagine what *that* used to cost in man-hours before this Sturtevant conveying system took over the job with "air at work."



2. It used to take 24 hours to dry the fur pelts that are used in making your felt hat. Today this huge Sturtevant dryer does the job in 15 minutes—another example of how "air at work" can help to step up production and cut costs.



3. At the tablet-forming machines in this drug plant, excess sulfa powder is recovered, dried, and conveyed to the packaging department with the help of Sturtevant "engineered air." Result? Better working conditions, better production — and thousands of pounds of sulfa powder saved each year.

4. Sturtevant air-conditioning helps to keep 'em rolling in this ball bearing plant, where precision is measured in microns. The complete system—including Precipitron*, the Westinghouse electronic air cleaner—safeguards product quality, results in fewer rejects, pays off in better working conditions and more efficient production.

*Trademark registered in U.S.A.

WHEREVER AIR CAN DO A JOB—you can count on Sturtevant for the right answer. As a division of Westinghouse Electric, Sturtevant is the *only manufacturing source* that offers all three types of equipment . . . for air handling . . . air cleaning . . . air conditioning. That means one responsibility for the entire system . . . one engineering headquarters with unlimited selection of components . . . service facilities everywhere . . . plus important savings from buying a "one package" installation.

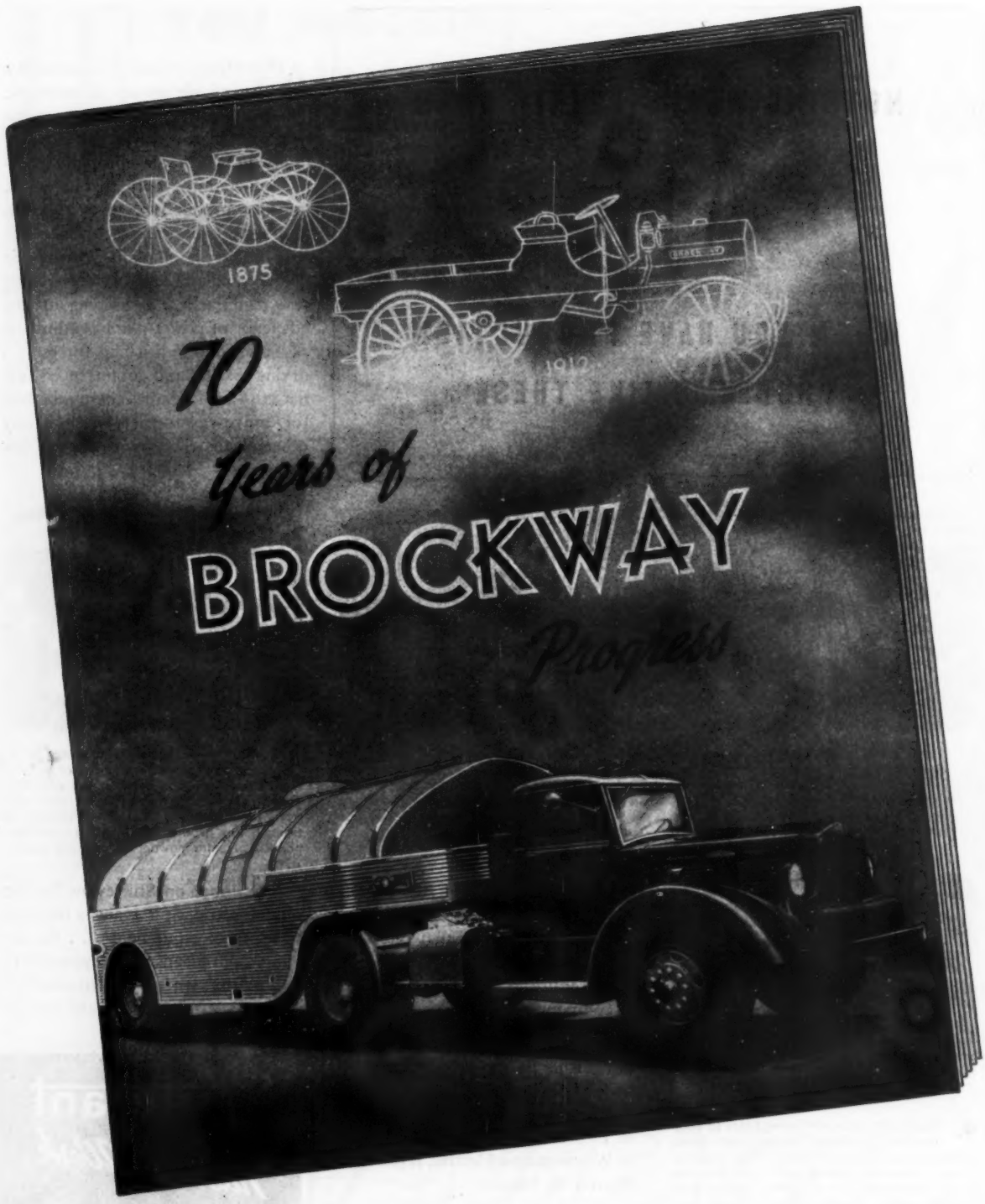
For further information, get in touch with the nearest Westinghouse or Sturtevant Branch Office, or write: B. F. Sturtevant Company, Division of Westinghouse Electric, Hyde Park, Boston 36, Mass.

Sturtevant
Puts Air to Work

B. F. STURTEVANT COMPANY • DIVISION OF
Westinghouse ELECTRIC

HEATING • VENTILATING • PRECIPITRON

AIR CONDITIONING • DRYING • DUST AND FUME CONTROL • CONVEYING • MECHANICAL DRAFT



BROCKWAY MOTOR COMPANY, INC.
Manufacturers of
BROCKWAY MOTOR TRUCKS
FACTORY & GENERAL OFFICE: CORTLAND, NEW YORK

NEW PLASTIC GARDEN HOSE

OUT in front, among the leaders of new postwar plastic products is GARDEN HOSE extruded by *Sandee*. Made of extremely tough vinyl type material in transparent and opaque green, this excellent product offers many superior advantages over old-fashioned rubber hose. Here are a few: feather weight, ⅓ the weight of rubber hose; less bulk, easier to handle and store; runs more water; lasts longer, no cracks, no leaks, no taping; unaffected by extreme atmospheric temperatures; resists oils, greases, alkalies, and solvents.

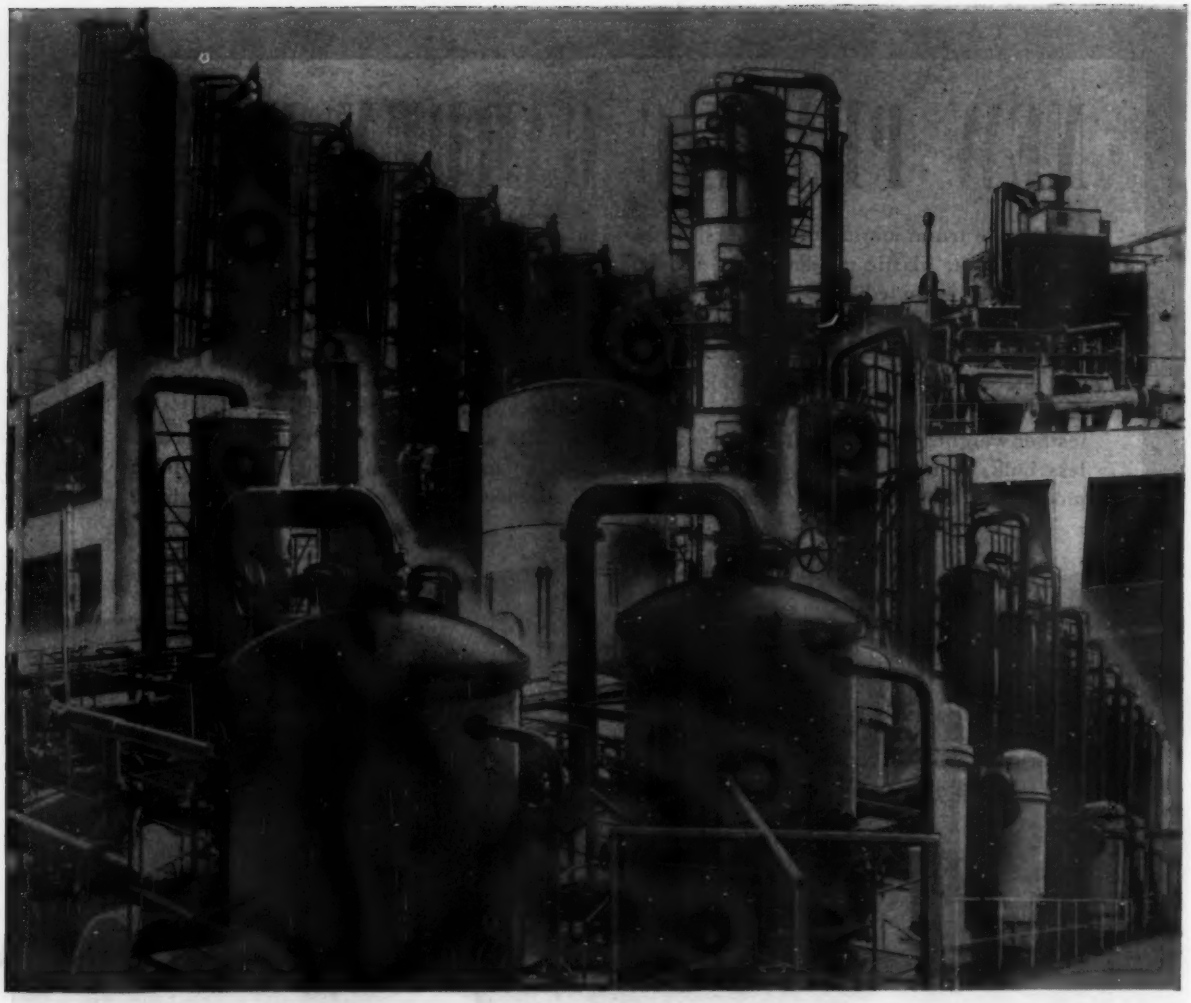
Once more, *Sandee* plastic research has added greatly to the improvement of a practical product. Chances are the skill and foresight of our technical staff can lend you valuable aid in applying extruded plastics to *your* manufacturing and merchandising problems. May we send you particulars?

SALES REPRESENTATIVES IN 19 PRINCIPAL CITIES

Sandee Manufacturing Company

3945 NORTH WESTERN AVENUE · CHICAGO 18, ILLINOIS

EXTRUDED PLASTICS AND SPECIAL TOOLS



VULCAN has the organization and experience for Development of *IMPROVED OPERATIONAL METHODS for the CHEMICAL PROCESS INDUSTRIES*

Economic Analysis of Requirements · Process Development · Process and Equipment Design · Fabrication and Erection · Initial Operation ·

For Production and Recovery of ALCOHOLS, ORGANIC ACIDS, ESTERS, ALDEHYDES, KETONES, ETHERS, GLYCOLS, PHENOLS, HYDROCARBONS, CHLORINATED HYDROCARBONS, ETC.

VULCAN

DISTILLATION • EVAPORATION • EXTRACTION
PROCESSES AND EQUIPMENT

THE VULCAN COPPER & SUPPLY CO., CINCINNATI, OHIO

FOR INDUSTRY

Carbon Black
Oil
Natural Gas
Natural Gasoline
Pumping Equipment
Pine Tar
Charcoal
Carotene
Chlorophyl

Swords to ploughshares might well describe what has taken place in the Cabot Shops in Texas. In wartime, Cabot quickly converted these shops so that big rifles could be made for the arsenal of democracy. Now those same shops have been reconverted to the tasks of peace. Once more they make pumps for the oil fields, and castings used in the Cabot plants for the manufacture of carbon black and natural gasoline.

CABOT CARBON CO.
TEXAS ELF CARBON CO.
GENERAL ATLAS CARBON CO.
CABOT SHOPS, INC.
VALLEY VITAMINS, INC.

CABOT

GODFREY L. CABOT, INC.
77 FRANKLIN STREET · BOSTON 10, MASS.

TWO GREAT NEW LABORATORY INSTRUMENTS

BROWNING MODEL RH-10 STANDARD FREQUENCY CALIBRATOR

Full, accurate use of station WWV, the world's finest primary frequency and time standard, is obtained from the Browning Model RH-10 Standard Frequency Calibrator. The standard Browning RH-10 is pre-tuned for 5 and 10 megacycles per second reception, at sensitivities better than ½ microvolt on either band. A dual filter system provides selection of either the 440 or 4000 cycle modulation of WWV for use as a primary frequency standard.

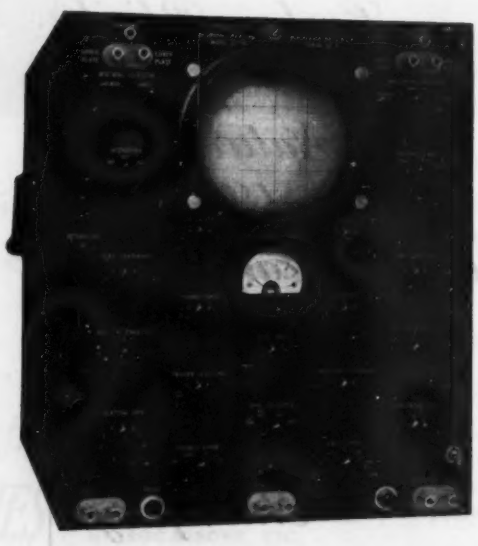
Checking equipment against station WWV, at accuracies up to one part in five million, the Browning Frequency Calibrator enables comparisons to be made in three general categories:

1. Precision radio frequency standards measurements.
2. Precision audio frequency standards measurements.
3. Precision time and pulse standards for physical measurements.

The Browning RH-10 consists of a high Q antenna transformer, a sharply tuned R-F amplifier, converter, oscillator, two IF stages, detector, selective amplifier output stages and a cathode ray zero beat indicator. Although normally supplied for 5 and 10 megacycles per second operation, any two combinations of 2.5, 5, 10, or 15 megacycles may be had on special order.

WRITE FOR DESCRIPTIVE LITERATURE

BROWNING MODEL OL-15 OSCILLOSCOPE



Designed for observing phenomena requiring extended range amplifiers and a wide variety of time bases, the Browning Model OL-15 Oscilloscope incorporates improvements that make it useful in numerous applications where ordinary oscilloscopes are inadequate.

For instance, the Browning OL-15 is particularly adaptable to television, radar and facsimile work, as well as with radio-frequency equipment where it is desirable to know actual r.f. waveform composition. The low repetition sweep gives visual observation when recurring phenomena of a few sweeps per second are encountered.

Suitable time base facilities for studying signals with a constant time difference, or those with an inconstant time separation between consecutive phenomena, are provided by the Browning OL-15. In general, the improved design and superior construction of the Browning OL-15 make it a highly flexible instrument for use in all laboratory work, production testing, or research applications.

WRITE FOR DESCRIPTIVE LITERATURE

BROWNING LABORATORIES, INC.
WINCHESTER, MASS.

YESTERDAY AND TODAY

WE'VE BEEN MAKING

GRAY PAY STATIONS

SINCE 1891

— and from the day Gray installed the first Pay Telephone in Hartford, the search toward perfection has never ceased. Just as today's Pay Station bears little resemblance to the early model, so do we expect tomorrow's improvements to make obsolete the machine of today. Gray looks to tomorrow with confidence and points to the new Gray Audograph as both here, as one result of that confidence. It incorporates the most advanced electronic principles.

Authorized Agents: Kellogg Switchboard & Supply Company • Graybar Electric Company • Stromberg-Carlson • Automatic Electric Sales Corporation • The North Electric Mfg. Company • Leich Sales Corporation • Northern Electric Company, Ltd. • Automatic Electric (Canada), Ltd.

THE GRAY MANUFACTURING COMPANY

W. E. DITMARS PRESIDENT • 16 ARBOR STREET HARTFORD 6, CONN. • (CLASS OF '21)

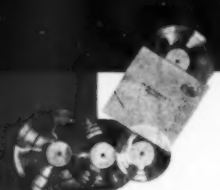
. . . AND TOMORROW

WE'LL BE MAKING THOUSANDS OF

GRAY AUDOGRAPHS

No other recording machine has all the features of the Gray Audograph — that's why it's worth waiting to see . . . and buy!

- **so rugged and stable it operates in any position . . . even upside down or on its side!**
- **handsome, compact (the fountain pen gives you an idea of its size). Weight about 12 pounds — dimensions 9½x9½x6½.**
- **easy to use - record or listen by the flick of a lever.**
- **instantaneous start-stop, back-space, visible correction marker, and lapsed time indicator.**
- **built-in speaker and jack for earphones or "soft" speaker.**
- **turn the knob at right to put any groove of the record under the stylus.**



The Audograph uses paper-thin Flexograph discs in three sizes:

5¾"—10 minutes recording time on each side
6¾"—16 minutes recording time on each side
8½"—31 minutes recording time on each side

THE GRAY MANUFACTURING COMPANY

HARTFORD 6, CONN. • 230 PARK AVE. NEW YORK 17, N. Y.

ACCURACY
Demands these Tools—
Production is assisted and maintained, in rate and quality, by precision tools. With Brown & Sharpe Tools to define measurements, the maintenance of accuracy required in manufactured goods is simplified – manufacturing costs kept within minimum limits.
B·S
STYLES AND SIZES FOR MOST REQUIREMENTS
MICROMETER TOOLS
RULES
COMBINATION SETS
PROTRACTORS
SQUARES
VERNIER TOOLS
GAGES
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BROWN & SHARPE MFG. CO.
Providence1,R.I.,U.S.A
BROWN & SHARPE TOOLS

BATH
IRON WORKS
CORPORATION

Shipbuilders and
Engineers

•

BATH, MAINE

THE TABULAR VIEW

Science. — Not often does The Review have the privilege of publishing as thoughtful a document as the Alumni Day symposium address of Vannevar Bush, '16, Vice-president of the Institute from 1932 to 1938, and now President of the Carnegie Institution of Washington and Director of the Office of Scientific Research and Development. Few others are as well qualified, by experience and ability, to discuss the important role which science is destined to play in our daily lives as is Dr. Bush, who (page 553) calls upon scientists and engineers to take a more active part, as professional men, in ministering to man's welfare. Those readers of The Review who may need an introduction to Dr. Bush — if any — will find, on page 568, the masterly treatment by which George R. Harrison, Dean of Science, worked his way out of a recent trilemma.

Food. — Prerequisite to an early peace is the problem of supplying the peoples of all nations with foodstuffs sufficient to meet their needs. Any such short-range program must be supplemented by a long-range program in which our technical knowledge of food production is shared with other nations, in the opinion of Henry A. White, President of the Hawaiian Pineapple Company. His Alumni Day address (page 557) outlines some of the many ways in which science and technology have increased food production and conserved much needed moisture and top soil through the use of new methods of fertilization, growth hormones, and contour farming.

Internationalist. — Norman J. Padelford, Professor of International Relations at the Institute, directs attention (page 561) to problems of international relations in a scientific era. He has served on the staffs of Harvard, Radcliffe, and Colgate, and immediately prior to joining the M.I.T. faculty, was Professor of International Law at the Fletcher School of Law and Diplomacy. During World War II, Professor Padelford served as member of United States Delegation, London Council of Foreign Ministers, as member of this country's delegation to Dumbarton Oaks, and as Executive Officer of the United Nations Conference at San Francisco.

Freedom. — Banquet address, on Alumni Day, was given by Paul W. Litchfield, '96, Chairman of the Board of the Goodyear Tire and Rubber Company. "Looking Ahead After 50 Years" (page 565) is certainly an appropriate title for an address by a member of the 50-year class. But while he looks forward, Mr. Litchfield also reminds us that we may learn well from the past. Today freedom and enterprise are as important to the development of the individual — and the nation — as when they were taught to him as a student at M.I.T.

Briefs. — Returning from a recent tour of Germany, Roscoe H. Smith, '23, provides an account (page 550) of efforts to restore German transportation and manufacturing. W. M. Breazeale, now Associate Professor of Electrical Engineering, at the University of Virginia, records (page 551) one phase of radar work which went on at the Radiation Laboratory during the war.

BETTER SURE THAN SORRY

According to olden legend Icarus flew too near the sun, only to spin in when his wings failed to stand the stress at high temperature. Here was an early case of serious trouble due to misplaced confidence in materials.

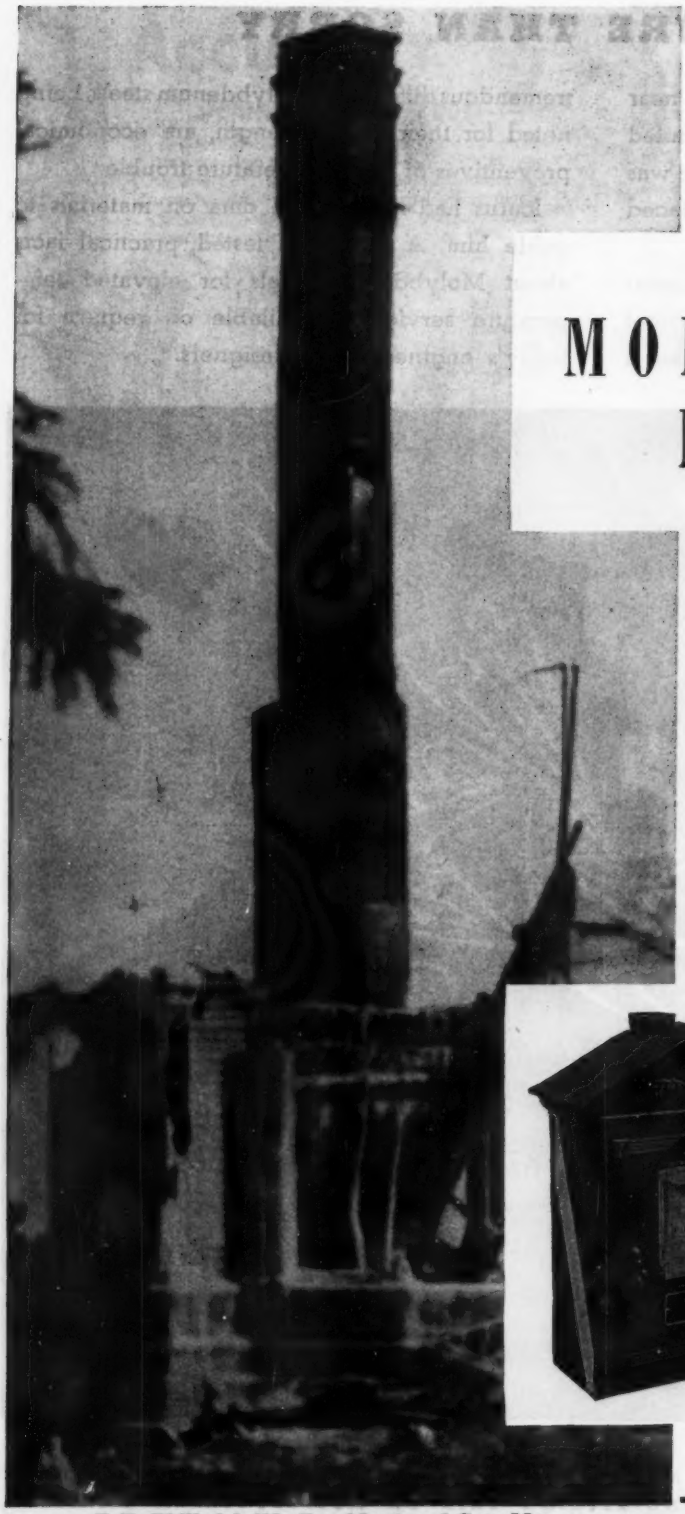
There are many applications for steel nowadays where creep strength (the ability of steel to keep working when the heat is on) makes a tremendous difference. Molybdenum steels, being noted for their creep strength, are economical preventives of high temperature trouble.

Icarus had no accurate data on materials to guide him. A wealth of tested, practical facts about Molybdenum steels for elevated temperature service is available on request for today's engineers and designers.

MOLYBDIC OXIDE—BRIQUETTED OR CANNED • FERROMOLYBDENUM • "CALCIUM MOLYBDATE"
CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.

Climax Molybdenum Company
500 Fifth Avenue • New York City

MOLY



A MONUMENT TO NEGLECT

Fire Destroys Property

When property is destroyed by Fire, the community and everyone in it loses — Yet the community may protect itself against loss of wealth — and income — by keeping the fire losses low. There will always be fires — the problem is to extinguish them while they are small.

Y O U Can Help

By urging your city government to provide adequate fire alarm box distribution. Prompt alarms reduce the fire loss and protect income.

F. B. Philbrick '18, *President and Gen. Mgr.*

E. J. McCarthy '20, *General Sales Mgr.*

THE GAMEWELL COMPANY

NEWTON UPPER FALLS 64, MASSACHUSETTS

IN CANADA: NORTHERN ELECTRIC COMPANY, LTD., MONTREAL

A Comprehensive Line of Turret Lathes—

FOR BAR AND CHUCKING WORK

The range of the Bardons & Oliver line of turret lathes covers bar work from 1/8 inch diameter or smaller to forgings or castings up to 15 inches. Each size in the line is outstanding in its own field for fast production and high quality work. In this era of keen competition and high wage standards Bardons & Oliver Turret Lathes will lower production cost and raise profit margin.

We suggest you submit your production problems and blue prints of your turret lathe work to our tool engineers for study and recommendation.

BARDONS & OLIVER, INC.

1133 WEST 9TH STREET • CLEVELAND 13, OHIO

A TIME-HONORED VETERAN OF THE PRECISION WORKER'S CRAFT

41 years of continuous service with Allis-Chalmers Manufacturing Co. are convincing testimony to the value of Olaf Olson as a precision worker and master of his craft. 66 years of service to the manufacturers and skilled workers of America have made Starrett Tools the outstanding choice of buyers and users wherever precision measuring tools are used.

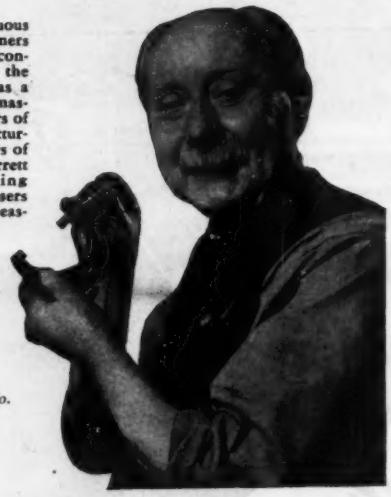


Photo courtesy Allis-Chalmers Mfg. Co.

THE L. S. STARRETT CO., ATHOL, MASS., U. S. A.
WORLD'S GREATEST TOOLMAKERS

STARRETT

PRECISION TOOLS • DIAL INDICATORS • STEEL TAPES • HACKSAWS
METAL AND WOOD CUTTING BAND SAWS • GROUND FLAT STOCK

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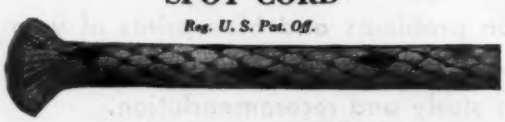


Our extra quality sash cord, distinguished at a glance by our trade-mark, the colored spots. Especially well known as the most durable material for hanging windows, for which use it has been specified by architects for more than half a century.

MAIL RETURNS

Grass In Other Pastures

FROM F. L. CAMPBELL:

I have been intending for some time to tell you that I greatly admire The Technology Review.

It seems to me that your magazine is the only one in this country that might be called a competitor of the Scientific Monthly in content. I must admit that, from an artistic point of view, you do a very much better job than we do. Don't be surprised if I should try to dress up the Monthly to improve its attractiveness.

Editor, Scientific Monthly
Washington, D. C.

Intelligence Level

FROM JOHN J. BROPHY:

I read with great interest the article by Professor Bitter, "The Scientist's Social Responsibility," and I was especially impressed with his suggestions for the practical application of mathematics to social problems. Some of the problems which he enumerated are truly fundamental to future progress along social-economic lines as he correctly indicates, and certainly the collection of adequate data is basic to their solution and therefore justified in every sense.

There is one problem confronting mankind, however, which transcends all others in importance which might eventually be solved by man, using the "scientific method," unless we are forever to regard it as a process of evolution and insoluble by man. This is the problem of raising the intelligence level of a sufficient portion of the human race to at least a point or degree where mass stupidity and consequently credulity will not continue to prevail to generate chaos. The answer to this problem, even in the next century, is worthy of the best efforts of creative science now.

Salem, Mass.

Compliment Enjoyed

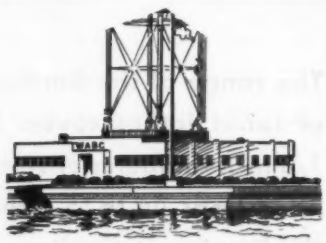
FROM SHIRLEY M. HALL:

May I thank you for your kindness in sending me copies of the May issue of The Technology Review on the cover of which is a reproduction of my print Harbor Peace.

(*Concluded on page 592*)

The Review is not published during the summer months following July. This issue, therefore, concludes Volume 48. Number 1 of Volume 49 will be published on October 27 and dated November. Readers who bind their copies are reminded that if they possess nine issues of Volume 48, their files are complete. An index to the volume will be ready on September 30 and will be supplied post free upon request.

Speed with Economy



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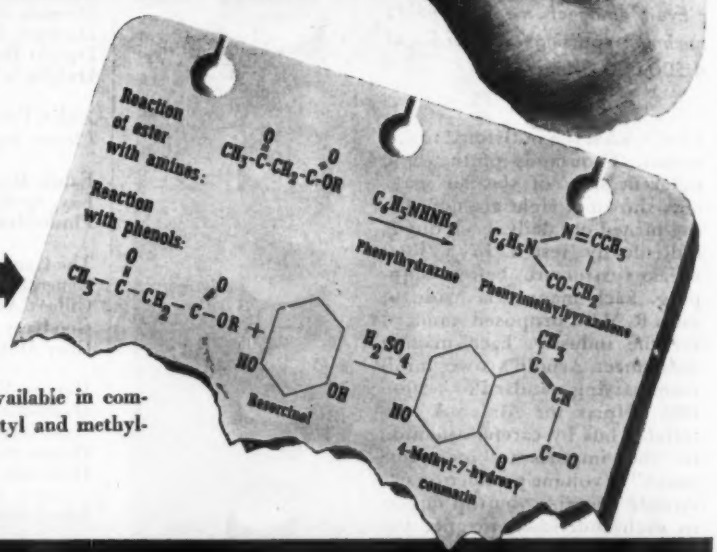

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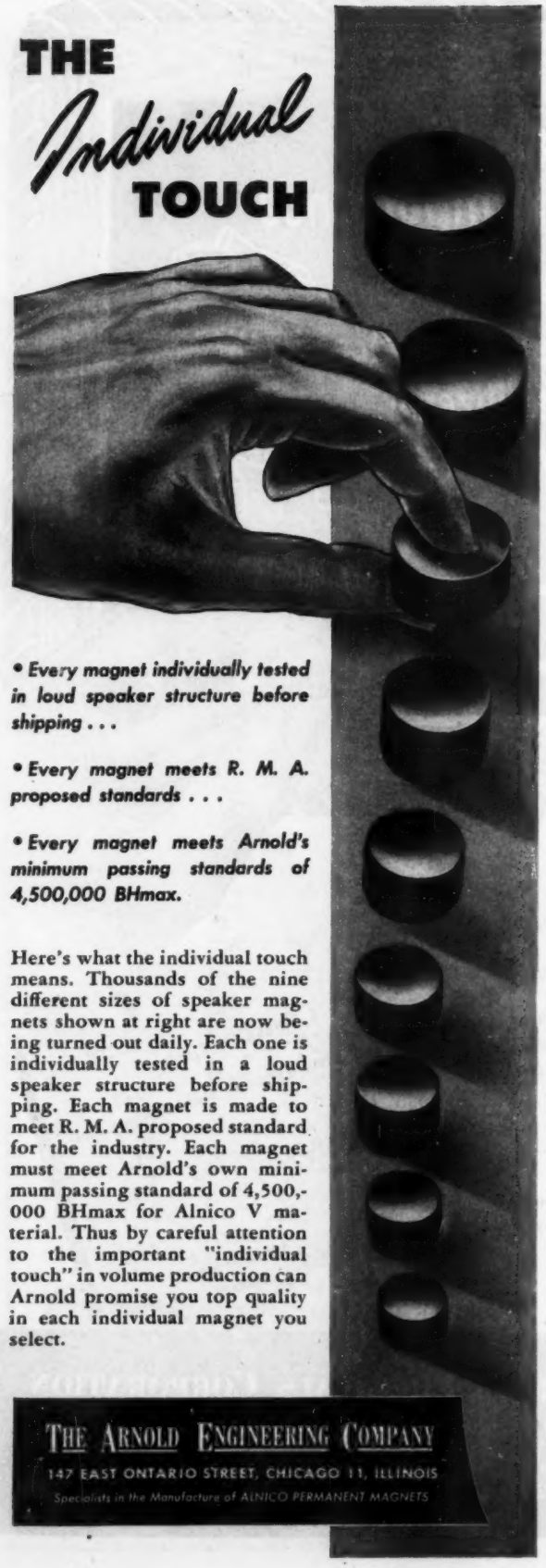

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Size	Nylon Yacht Rope	Manila Yacht Rope	Linen Yacht Rope
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7/16"	3750	1930	2425
1/2"	5000	2920	3200
9/16"	6400	3800	4050
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3/4"	—	5940	5910

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3/4"	10000	5400
7/8"	13000	7700
15/16"	15700	—
1"	18300	9000
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1-1/2"	—	18500

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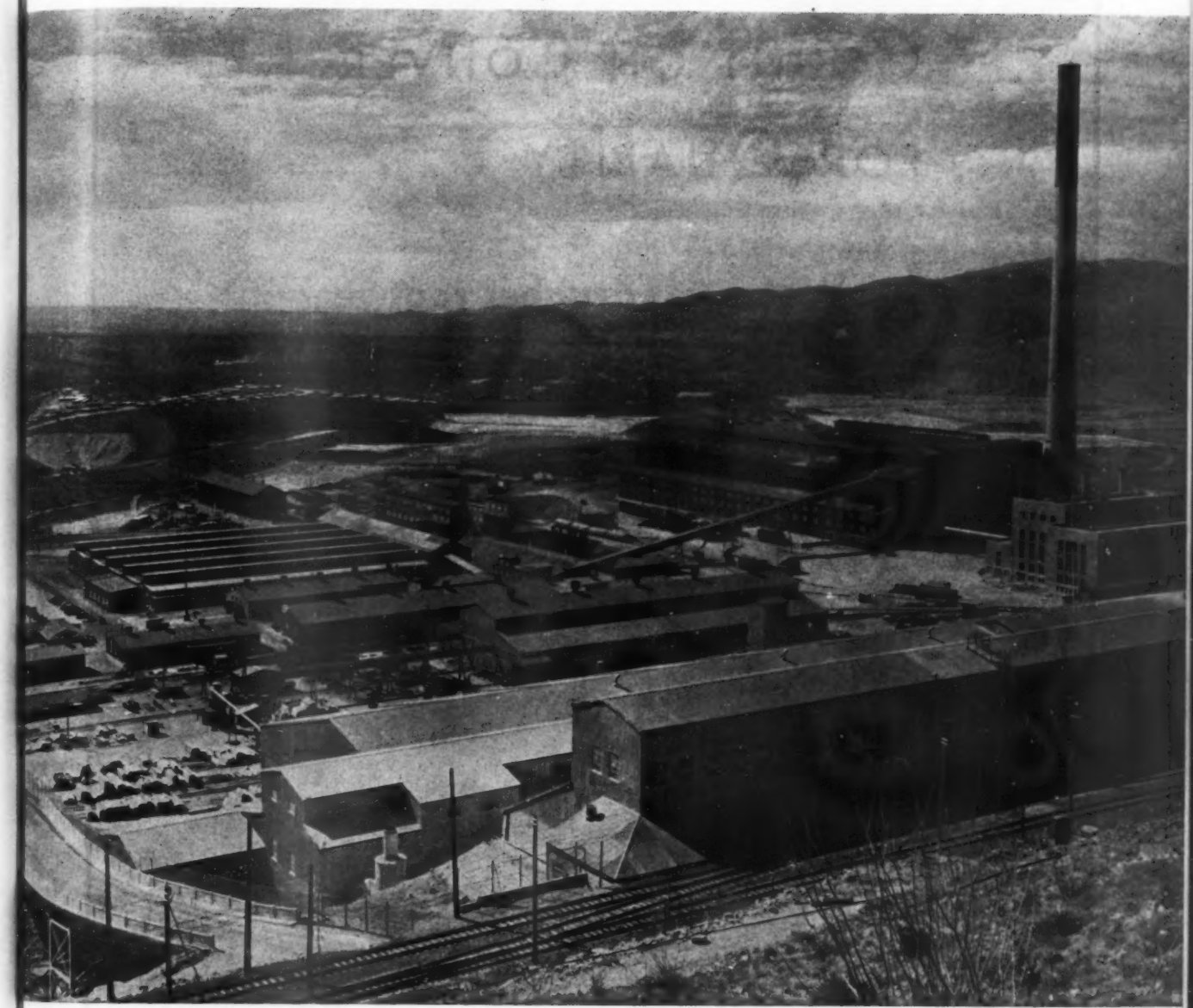

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VOLUME 48 NUMBER 9

THE TECHNOLOGY REVIEW

TITLE REGISTERED U. S. PATENT OFFICE

EDITED

AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Stanley Witt

Trees in Mexico

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Photo by William M. Rittase

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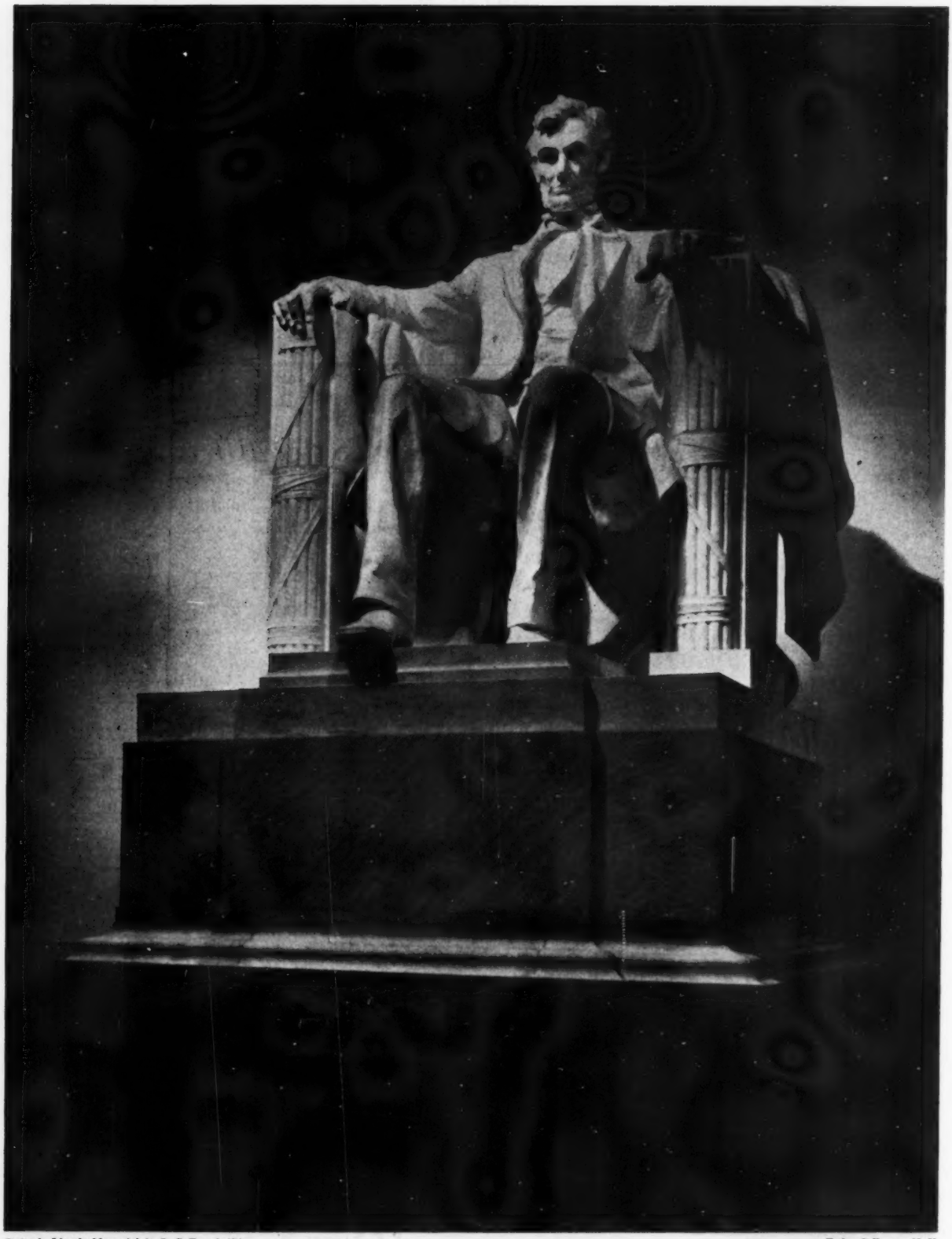


Statue in Lincoln Memorial, by D. C. French, '71 *Ewing Galloway, N. Y.*

With malice toward none; with charity for all; with firmness in the right, as God gives us to see the right, let us strive on to finish the work we are in; to bind up the nation's wounds; to care for him who shall have borne the battle, and for his widow and his orphan—to do all which may achieve and cherish a just and lasting peace among ourselves and with all nations.

Lincoln's Second Inaugural Address.

THE
TECHNOLOGY
REVIEW

Vol. 48, No. 9 July, 1946

The Trend of Affairs

Wartime Waste

HARDLY any activity during the war directly involved a greater proportion of the civilian population than the various government-sponsored scrap drives. This was true not only for the United States but even more so for the other major belligerents, most of them far from affluent in raw materials. The iron fence around Buckingham Palace was cut down with much ceremony. Iron manhole covers disappeared from the streets of Japan, to be replaced with wood or concrete. Government-sponsored collections began in Germany in 1936, under the gentle guidance of storm troopers, and, as needs grew more desperate, copper roofs, church bells, and many issues of coins were collected or confiscated.

In this country, always comparatively well supplied with most essential industrial metals, collections got into full swing only after we were already at war. The War Production Board estimated that the activities of its salvage division had aided in the gathering of about 6,000,000 tons of scrap a year which might not otherwise have been available to industry. Some of the metal came from unexpected sources. The Hotel Ansonia in New York contributed the metal ornaments on its roof, which few could see anyway; also several tin beer coils from its bar.

The basic reason that drove the governments to enlist large segments of the population in the scrap drives, most of them untrained in the rather elaborate requirements of the scrap industry, is that labor is the biggest single item in the cost of scrap. Left to economic law, scrap will not be gathered once it becomes too diffusely spread or too difficult to be separated into components which industry can use.

Although it may be an exaggeration to say that the "collection drives held in various parts of the country had little success," they sometimes produced unexpected results. Officials in charge frequently found themselves with large, unsightly piles of pots, baby carriages, old bath tubs, and similar items which processing industries, although badly in need of metal, were coy about accepting. Aluminum kitchen utensils, turned in by housewives under the impression that they would be melted immediately into fighter planes, were so contaminated with iron and other undesirable materials that much of them could be used for little else than the prosaic but useful job of "killing" or scavenging molten steel. In England the collection and segregation of domestic scrap by local authorities was relaxed after 1943 and the job turned over to firms with the equipment and knowledge required to process scrap into grades suitable to the exacting requirements of industry.

Nevertheless, the heavy and, in some cases, dangerous inroads which war demands made on our reserves of raw materials might have been far worse were it not for the availability of enormous tonnages of secondary materials. The iron content of the scrap used by this country's steel mills in 1943, for example, substantially exceeded the iron content of all the ores, domestic and foreign, that went into the furnaces. That was the average. For steel mills in the New England area, scrap supplied 69 per cent of the iron used; in the Pacific area, 87 per cent; and the few plants in the Southwest ran almost 100 per cent on scrap. Contributions to the manufacture of nonferrous metals were not quite on the same proportionate scale, nor did scrap, as it sometimes does in peacetime, supply more metal to the furnaces than do the mines. But of the scrap metals used in 1943 there were more than 1,000,000 tons of copper, 368,000 tons of zinc, and 341,243 tons of lead.

Battlefield scrap turned out to be of minor importance, in spite of the tremendous quantities potentially available. A recent dispatch from Bengasi, Libya, describes that area as a "great boneyard" littered with the skeletons of hundreds of planes, tanks, water cans, and the other paraphernalia of modern armies. Sixty-seven wrecked ships lie in the harbor. But the absence of trained labor, processing facilities, and near-by markets, as well

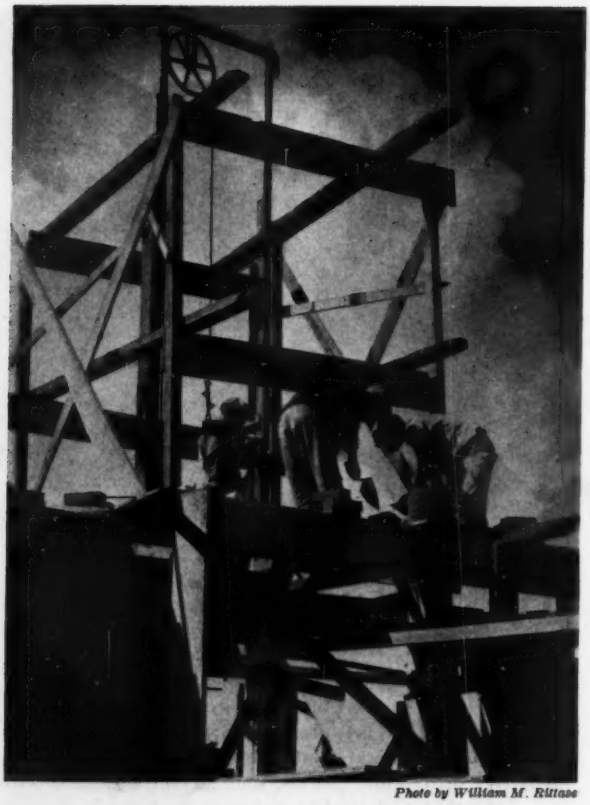


Photo by William M. Rittase

as the relative inacessibility of much of the scrap may make it unattractive to gather this material for an indefinite period. The Army's present policy, in fact, is to return iron and steel scrap only as ballast, except from Japan and Germany, where the amount gathered will depend on labor conditions. More effort will be made to return nonferrous scrap, particularly lead- and tin-bearing materials, but copper-bearing scrap gathered in Allied countries will be sold locally to aid in rehabilitation.

Quite aside from difficulties in getting it, some battlefield scrap presents unusual difficulties to the wrecker. During the first part of 1943, for example, wrecked foreign and American planes were brought into this country in fairly large numbers. Attracted by the possibility of buying aluminum planes at a fraction of a cent a pound and selling aluminum scrap at five or six cents a pound, some dealers bought these planes freely. Explosions from ammunition, gas tank vapors, and hydraulic system fluids became so frequent, however, that the War Production Board soon put restrictions on the further sale of such planes, and importation was stopped entirely early in 1944. The fact that the metals in these planes were heavily and expensively alloyed to get the utmost in physical properties was no asset to the scrap metal dealers, for some alloying materials, such as chromium, tend to be lost during remelting, and the others can be worse than useless.

The record-breaking amounts of scrap that helped to keep American metallurgical industries going came mostly from what is called industrial scrap — the turnings, clippings, and other leavings resulting from the production of new equipment. As industrial production rises, so does the quantity of such scrap. War accentuates this trend, for military equipment, designed in general for more severe service and with less emphasis on economics, produces proportionally more scrap than civilian goods. Four times as much "new" copper scrap, to quote a somewhat extreme case, was produced in 1943 as in 1939. Nevertheless, although most of the iron, aluminum, and copper scrap used during the war was of the new or industrial category, most of the lead, tin, and antimony was old scrap, from obsolete equipment and similar sources.

Motors to Restore German Industry

By Roscoe H. Smith

WITHOUT question, German industry has received a staggering blow as the result of the war. Germany is turned upside down, and her industry, completely disorganized, is struggling to operate sufficiently to support at least the civilian needs which the military occupation governments are trying to meet. Today, amid scenes of great destruction, life and business in Germany are being reorganized to a strange and uncertain future.

Labor is ample. Many operations have for years been done by women who are not only available but anxious to work. One important reason for such willing industriousness is that food rations are graded by useful occupation as well as by personal need. Therefore, one who is lazy is likely to feel the pangs of hunger more quickly than is his industrious neighbor.

Cities which were spared destruction are few and far between — an example is Heidelberg — but there are a considerable number of manufacturing plants which have survived the war with little more than a single bomb hit, if they have been damaged at all. Machine tools have come through the bombings surprisingly well. In fact, unless hit directly, machinery in general does not appear to have been harmed beyond reasonably easy repair.

The same cannot be said, however, of the electric motor industry, which bears a large burden in the industrial rebuilding of Germany. Many of the electric motor plants are severely damaged. In some plants temporary repairs to buildings have made it possible to resume operations with outputs limited to about 20 to 25 per cent of normal.

To the extent that an electric motor manufacturer can do any work at all, the military government is sending to it hundreds of motors to be rewound, reconditioned, or even completely rebuilt. Motors for street railways, electric locomotives, sanitation plants, refrigeration plants, and similar public needs and services are among those for which repair or replacement is most urgently needed. The limitations on motor manufacturing on the Continent today are principally three in number: (1) the difficulty encountered in securing and transporting materials such as copper wire, steel sheet, shaft steel, castings, and insulation; (2) the lack of fuel; and (3) the reduction in supervisory personnel.

In Germany, the size and weight of a motor reflect the general practice of trying to make a little go a long way. Even before the war, sheer necessity forced Germany to build motors with a very small available reserve for overload. The Germans cannot get any more out of a pound of copper or iron than can we in the United States. But comparatively low labor costs and high material costs in Germany have resulted in emphasis being placed on the saving of material rather than on the saving of labor. The

situation is quite the reverse in the United States, and hence manufacturing practices reflect the different economic conditions.

Investigations of electrical designs in both alternating current and direct current motors indicate that, for active materials used, the results are as would be expected from American practice. In Germany, the sizes and weights of motors also reflect the general practice of allowing higher temperature rise in operation. Ribbed surfaces to increase heat dissipation are used more generally than in the United States, and large diameter fans on rotors and armatures are common.

The Germans had a lot of aluminum and used it instead of copper for the stator winding of squirrel cage motors. Some motors were also built using aluminum for commutators. The aluminum commutators were not considered satisfactory because of the rapidity with which they roughen from arcing. Better results were obtained with soft iron commutators with thin sheets of copper between the iron and the insulation. Engineers who had worked on this development believed that material from the copper sheets was deposited on the iron segments and that this copper deposit protected the commutator surface from rust. The commutators were far inferior to copper commutators, however. In one case, carbon had been tried as a substitute for copper in commutator bars, but although the carbon commutators were successful electrically, they were mechanically weak.

The use of glass fabric insulation, instead of mica, was developed and adopted by one company. On an experimental, and therefore relatively small, scale, another company had gone into the development of synthetic mica made of quartz.

Whether Germany is to rise again as an industrial nation will not be settled for some time to come, in all likelihood. Meanwhile, the German electric motor industry has its hands full in simply rehabilitating equipment damaged or virtually destroyed as a result of the concentrated bombings delivered by the Allied air fleet in the closing months of the war. It will be some time before the motor manufacturers can take care of the repair work now on the docket, even though they may be capable of working at nearly normal efficiency. Meanwhile, American motor manufacturers appear to have made so much more progress in the use of new materials and better application of old ones that, with rare exceptions, there is very little to be adopted from even the best of the German practice.

Noise in Microwave Receivers

By W. M. Breazeale

ONE phase of the Radiation Laboratory work, as mentioned by Dr. du Bridge and Dr. Ridenour in their article "Expanded Horizons," published in The Review for November, 1945, was the development of microwave radar receivers with the best possible sensitivity. The absence of atmospheric static at microwave frequencies makes it possible to utilize any degree of sensitivity which can be obtained. An investigation of the factors affecting the operating range of radar equipment over line-of-sight paths discloses that this range is directly proportional to the fourth root of the transmitted power and also to the fourth root of the power sensitivity. Decreasing the noise level of a radar set to half its previous value may not be as sensational as increasing the transmitted power from 1,000 kilowatts to 2,000 kilowatts, but the increase in range is just as great; hence, the large amount of work done in improving receiver performance.

The sensitivity of a microwave radar receiver is determined by the noise level in the early stages. The theoretical lower limit is set by the thermal-agitation-noise — noise arising from thermal agitation of electrons which are free to move in conductors — in the input of the receiver. The electrical power produced by noise and available at the input of the receiver is about 5×10^{-15} watt for a typical radar set. The sensitivity or "noise figure" of the receiver can be expressed as the ratio of the signal power to noise power input required to give an output signal equal to the noise. Obviously the poorer the sensitivity the larger the noise figure. Noise figures of microwave receivers may be as low as four or five.

Early in the war it became evident that means must be found to measure the sensitivity of microwave receivers in the laboratory. Such sensitivity measurements involved the determination of signal power levels in the neighborhood of 10^{-13} watt. Absolute power measurements are difficult to make at levels less than one microwatt. Therefore, it became necessary to produce signals at power levels that could be measured accurately and then to reduce the power level to the desired value by means of an attenuator. An accurate microwave attenuator with a power range of 10^8 was necessary to reduce the signal below the micro-microwatt level.

A suitable device for this purpose at microwave frequencies could not be constructed using apparatus and methods which would be satisfactory at broadcast or

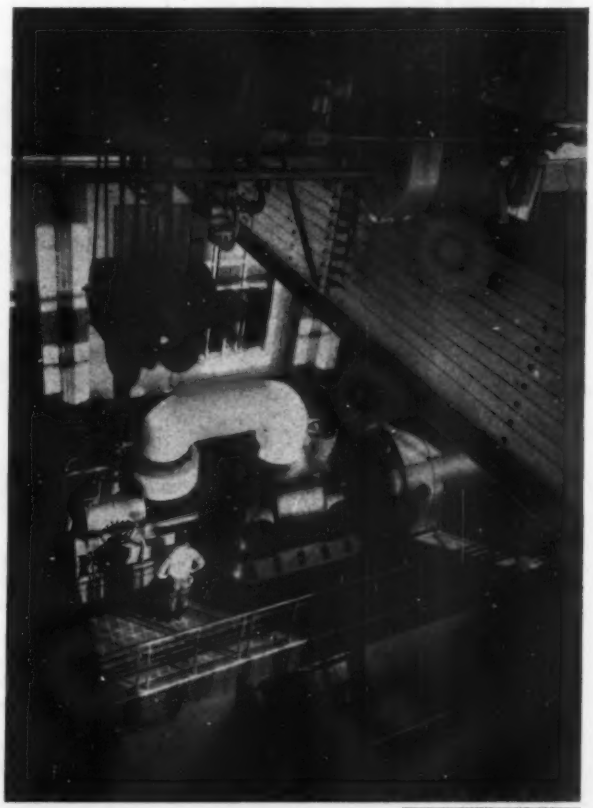


Photo by William M. Ritman

other lower frequencies. Waveguides * — hollow metallic ducts through which microwaves could be "piped" if the cross sectional dimensions of the guides were greater than a half wavelength — lent themselves to this need. It was simply necessary to use waveguides under conditions for which the microwaves could not be efficiently transmitted — *i.e.*, for frequencies less than "cut-off."

Fortunately, the theory of waveguides had been worked out to the point where the attenuation of an electromagnetic wave at frequencies less than cut-off could be accurately calculated from a knowledge of the diameter and length of the guide. The attenuation is very high in this region, and a waveguide operated under these conditions proved to be a satisfactory microwave attenuator.

At present there are no vacuum tubes which will amplify satisfactorily at microwave frequencies. As a result, microwave radar receivers use a superheterodyne circuit with the initial stage acting as a frequency converter to reduce incoming signals to frequencies which can be successfully magnified. Because it produces less noise than a vacuum tube, a crystal is generally used as the frequency converter. An analysis of the operation of such a converter shows that crystals are very quiet but that their conversion gain is less than unity — *i.e.*, the output voltage is less than the input voltage. On first glance it might seem that a noisy crystal with a small conversion loss would be as good as a quiet crystal with a large conversion loss. Further analysis shows however, that when the conversion efficiency is small, noise in the circuit following the crystal contributes appreciably to the overall receiver noise. Thus, noise in the amplifier following the crystal will have a greater effect on noise in the receiver when the high loss crystal is used.

These and other considerations pointed out the desirability of making separate determinations of the crystal's noisiness and conversion loss. Tests were evolved for making these measurements, and these replaced the simple noise figure determination described earlier. In essence, the first quantity is measured by comparing the noise output of the crystal excited by the local oscillator with the thermal-agitation-noise of a resistor, and the second by input and output power measurements. Happily it turns out that the latter can be made at a comparatively high level. Today these tests are part of the routine of crystal production.

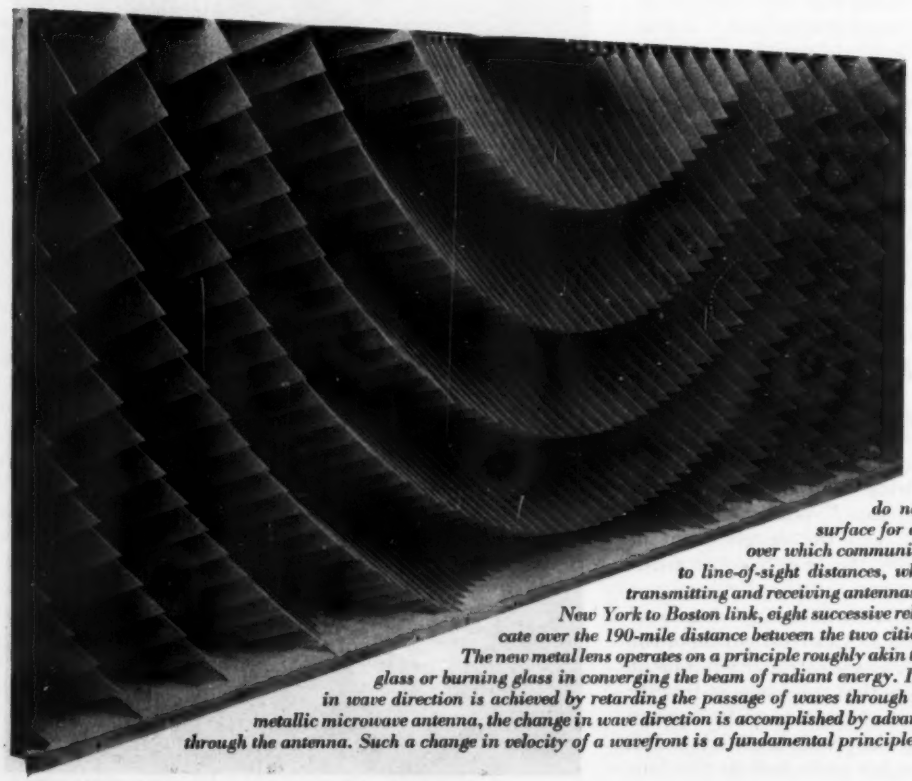
The significant part of this study is simply that it made possible considerable reductions in the noise of microwave receivers and in so doing brought back into circulation the crystal detectors of the early days of radio broadcasting. The importance of noise reduction is recognized when it is realized that noise reduction was the most important single factor which made possible radar contact with the moon last January.

* Independently developed by W. L. Barrow, '29, and his associates at the Institute and by George C. Southworth and his associates in the Bell Telephone Company about 10 years ago.

Illegitimate Yeasts

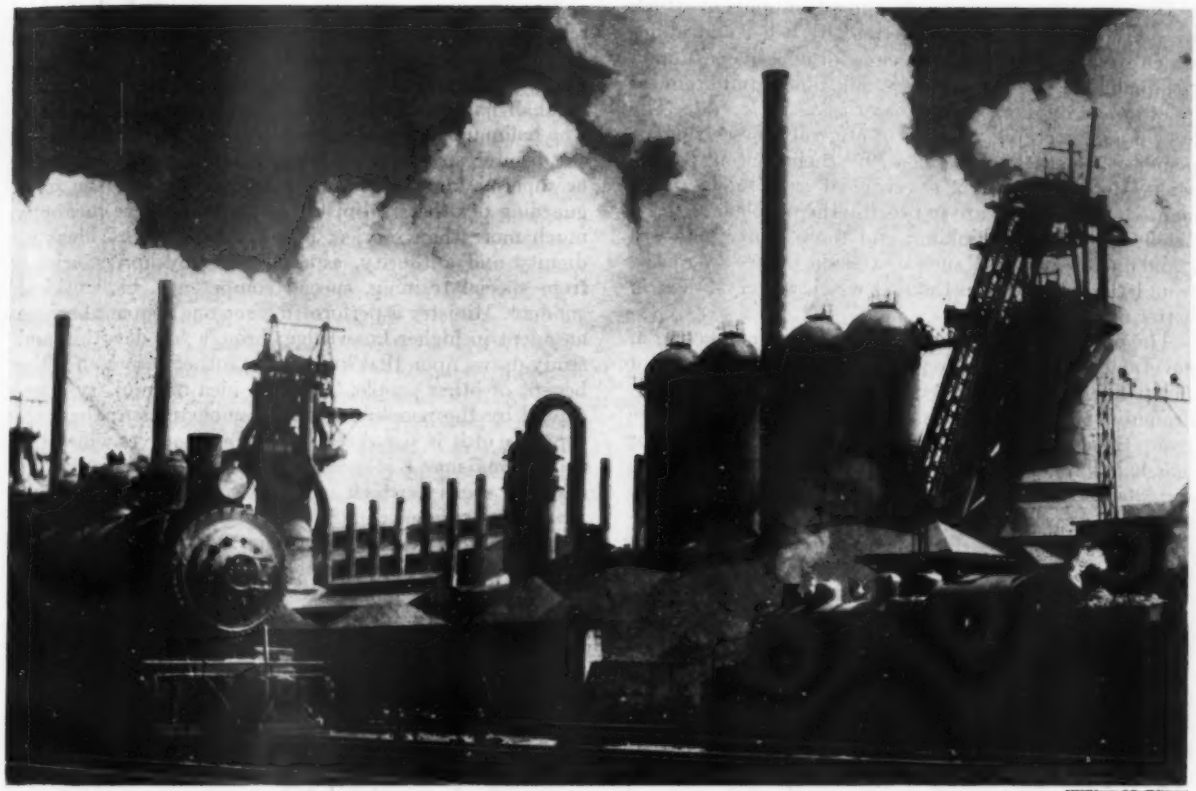
IN human society illegitimacy is often, if unjustly considered to be a stigma; but among the yeasts, most valuable of the microbes that serve man, illegitimacy is an asset. To grasp the significance of legitimacy in the reproductive processes of yeasts, we must consider briefly recent discoveries in yeast genetics.

Yeasts reproduce mainly by a simple asexual process called "budding," whereby daughter cells appear as protuberances on the periphery (*Continued on page 582*)



Futuristic motif characterizes this view of half of a newly designed directive antenna for focusing ultrahigh-frequency radio waves in a manner similar to the collimation of light beams by means of Fresnal lenses. This unusual type of radio antenna, developed by the Bell Telephone Laboratories, inaugurates a new era in the design and construction of microwave radiating systems. Most immediate use for the new lens-type antenna is its application to microwave radio relay systems such as that now under construction between New York and Boston. In radio communication, microwaves behave much like optical waves. Unlike longer radio waves, microwaves do not follow the contour of the earth's surface for any appreciable distance. The range over which communication is effective is therefore limited to line-of-sight distances, which depend on the elevation of the transmitting and receiving antennas but is of the order of 30 miles. In the New York to Boston link, eight successive relay stations will be used to communicate over the 190-mile distance between the two cities.

The new metal lens operates on a principle roughly akin to that of a simple convex magnifying glass or burning glass in converging the beam of radiant energy. In the case of a glass lens, the change in wave direction is achieved by retarding the passage of waves through the glass, whereas in the case of the metallic microwave antenna, the change in wave direction is accomplished by advancing the wavefront as the waves pass through the antenna. Such a change in velocity of a wavefront is a fundamental principle of all lenses.



William M. Rittase

Science, Strength, and Stability

In Coming of Age as a Profession, Science Imposes New Duties on Scientists and Engineers in the Problem af Attaining National Harmony and International Peace

By Vannevar Bush

THE international peace which is demanded by thoughtful men the world around is not the mere absence of war. It is something far more positive than that — it is a condition of amity and cordial collaboration among independent national groups, each confident in its own vigor, within an international framework. It is thus dynamic, not static; progressive, not stagnant; pioneering in all fields where general betterment of man's spiritual and material life may be expected. We have not had it for many a long year. We do not have it now. Yet peace must be secured if the human race is to continue. We have faith that it can and will be assured.

But faith without work is not enough. For the boon of this peace to be attained, and for the heart-rending scourges of destruction, disease, famine, and despair to be lifted throughout the world, there is work, much and great work, to be done. It is only as all sorts and conditions of men do their share unselfishly that there can be created in each of the peoples of the world the self-confident vigor which is the essential precursor of unstinted world collaboration. Whatever the ultimate world system toward which we are tending, whatever there may be surrendered of individual sovereignty by the nations in the interest of that system, its strength and stability will have to be drawn from the several states composing it. Recognizing this imperative condition, we recognize that the first task laid on every group in our wonderfully varied population is to give, seriously and consciously, its best effort to the creation — and the enhancement — of strength and stability in the United States.

We are concerned here today with the general subject of technology and international peace. What is technology? As contemplated here, it cannot be regarded in isolation. It cannot be considered apart from the science out of which it grows and the engineering through which it is usefully expressed. We must deal with all three of these concepts — basic research, applied research, engineering. Let us then for convenience speak primarily of science, the general area in which all three concepts operate. How then, may scientists aid in the establishment and growth of the national strength and stability essential to amity and active concord among nations?

Democratic government, to the philosophy of which we are committed by heritage and by belief and under which we have prospered, depends for effectiveness upon the quality — the thoroughness, substance, and keenness — of public thinking on the major issues of the day. The acts of a democratic government are truly the acts of the people whom that government, by their consent, represents. If acts of such a government are faulty, short-sighted, unjust, they are so because the people have been heedless, selfish, unthinking; and those faulty acts will stand uncorrected until such time as the people are roused from lethargy to serious thought which will crystallize in better action.

The public thinking which thus comes to expression in government action, is the product of two forces. One of these, like the sparks over a lava flow, is spectacular, dramatic. It is the force exerted by the extreme pressure group rallied for specific action on an immediate issue or marshaled for continued agitation in support of some special interest. It can at times extend to coercing government while working lawfully within the frame of government. It is essentially direct action for self-interest. Not all direct action, fortunately, is of this kind; men can apply their energy and their skill directly to public problems with no self-seeking, and men do, as we all know. We need more such men.

The second force in the formation of public opinion, like the lava flow itself, moves more slowly and with far less of superficial drama. It is a vast force and in the end produces fundamental change. This is the force that operates through the long-term development of matured public opinion by the gradual influence of enlightened and disinterested citizens. Government by the people is really government by that portion of the people which takes the trouble to participate actively in the forming of public opinion. It is this fact which explains the feeling of responsibility for discussion of public questions and for sincere consideration of them — the feeling that every thoughtful man has experienced. It is indeed this fact which gives meaning and significance to a gathering such as this present one, where in all humility we try to examine into great issues and to determine our proper part in the resolution of them.

Professional groups in the nation are particularly aware of this feeling of responsibility — this duty — to take a conscious part in guiding the growth of public opinion and thus in shaping the forces which result finally in governmental action. This is a serious matter; it is no light thing for a man or a group to undertake deliberately to evoke and direct such forces. But professional men realize that theirs is a special obligation, for they must recognize that they, in their education and professional training, have benefited especially from the existence of organized society. They realize, too, that they stand in a unique relationship to other groups in the population and in a unique relationship to the population as a whole, and that the implications of that relationship are extremely important, not merely to them but far more to the people in general. This realization has always rendered the professional groups reluctant over plunging into militant partisan political action, for fear of jeopardizing that relationship. Yet by acceding to this requirement for caution they impose uneasiness upon themselves, for the recognized obligation — the social debt — still stands, and they are concerned over it.

To understand what this unique and socially valuable relationship is, and whence it comes, both defines the idea of a profession and explains the origin of the professional man's concern over the question of how and how much he shall participate in the formation of public opinion. The hallmark of a profession is ministry to the people — the disinterested and authoritative employment of special or superior knowledge for the counseling and the safeguarding of others. Ministry in the sense here meant is much more than service; it is marked by the ideas of dignity and authority, especially the authority arising from special training, special competence, high ethical conduct. Ministry is performed when one who has become an adept in higher knowledge through his devotion and study draws upon that knowledge authoritatively for the benefit of other people. That the idea of ministry is accepted by the people needs no demonstration; their acceptance of it is signalized by the prerogatives which the professional man is allowed to maintain, by his distinctive place in society, which is his because the people have reason for confidence in the integrity of his profession and for belief in its general beneficence.

That confidence and that belief are derived in some measure from the public's respect for the body of knowledge in which a professional group is adept and which it administers — a respect based both on the fact that the knowledge is personally valuable to the individual citizen and on the fact that the dignity of tradition and long heritage clings to it. In larger measure, however, the confidence and belief of the public in the beneficence of a profession are based on the fact that in their ministry to the people the members of that profession are disinterested, seeking first and foremost only to perform their ministry honestly and ably as required by their self-imposed code of ethics. I do not mean to imply by this statement that ministry inevitably demands a vow of poverty. If he is to be truly effective, the professional man may properly insist that he receive for his work a material return adequate to keep his mind free for full and effective performance. But his interest in material return is secondary. If it becomes primary, he ceases to be a professional man.

Since the authority and dignity which the professional man must have for the full performance of his professional function rely so heavily upon the fact that he is recognized as free of a controlling self-interest, it is natural enough that he should weigh carefully the matter of participation in political affairs. If he compromises his disinterestedness, he risks prejudicing his ministry. And he knows the importance to the people that that ministry be not prejudiced. At the same time, he cannot but recognize that the disinterestedness of the professions can often supply a highly needed balance wheel in social mechanisms, and that very often the authority of the professions in their own callings may lead the people to look to them for sound counsel on other matters.

For emphasis, I have set this dilemma out in large and plain terms, taking the hazard of overstating it in order to gain the advantage of putting it bluntly. We know that professional groups sometimes resolve it, for we know that they can and do contribute to strength and stability in government by directly sharing in and influencing the public thought on which these depend. On some occasions they have done so at no inconsiderable risk to their unique relationship to society, yet I believe that even

that risk can usually be avoided. It is instructive to review summarily the general course which some of these groups have followed.

The clergy, whose position as a professional group is most clearly a consequence of ministry to the people, have for centuries contributed to governmental vigor by their influence as a profession quite apart from their most profound personal influence as men of God. More and more in recent times they have taken the route of direct action, with all that implies of committees, petitions, signatures on manifestoes, and other activities, very often having to do with issues most remote from the professional competence of the individuals involved. In all likelihood, however, the vital effectiveness of the clergy in raising the general moral tone of the public mind, in increasing our responsiveness to humane values, has come in greater measure from the long-range indirect influence which is characteristic of true ministry, and there is serious question within the profession itself whether the superposition of direct activities is worth what it costs. In fact, this question is as old as organized religion itself.

The profession of medicine, with its long and distinguished history, its high degree of organization, and its unique code of professional conduct epitomized in the time honored Hippocratic Oath and vigorously maintained by the traditions of the profession, had and has great power and influence. We have seen sweeping changes in public thinking about sanitation, public health, and similar matters in the past hundred years. Yet it is only a little more than a hundred years ago that Dr. Benjamin Waterhouse was a voice crying in the wilderness here in Cambridge. The enlightenment that has come in the century since his time is testimony to the force which medical men have exerted. They have contributed greatly, as individuals and as a professional group, to the development of a public responsiveness and receptiveness that not merely accept but actively demand legislation unthinkable a hundred years ago. In the main, moreover, the profession of medicine has secured these and other good results not by short-range direct action, but rather by its long-range influence on the public mind.

Resembling medical men in their holding a particularly specialized place in the community, in their firm and comprehensive organization, and in their administration of self-imposed standards of professional conduct, lawyers as profession men are set apart by the fact that, in a government which is of laws and not of men, they stand necessarily in a special relation to public affairs. So much of the lawyer's work is done in terms of immediate issues, so many demands are imposed on him by the day-to-day hurly-burly, that it is easy for men outside the profession, and indeed, for some lawyers themselves, to lose sight of the core of knowledge and ministry that renders the law a profession in the real sense. For the same reason, lawyers in their endeavor as professional men to contribute to the formation of public opinion often appear mainly to be engaged in direct short-range action. But it is a fair question whether their long-range influence, as exerted by an Elihu Root or an Oliver Wendell Holmes, is not the greater source of the power which this profession wields in clarifying public thinking on great questions of justice and human rights.

Other professional groups in the population, partly because they are inherently more loosely defined than these three, partly because the knowledge which they administer is more remote from the daily concerns of the people, cannot be so clearly traced in their influence on public thinking. Teachers, for instance, constitute a profession, but it is not so homogeneous as the medical profession, perhaps because it lacks the provisions for indoctrination of neophytes and the formalization of entry into mastership which are characteristic of such organically matured professions as medicine and the clergy. No one would fail to recognize the great influence for good which teachers exert altogether apart from their work of instructing the youth in a particular discipline, yet to trace the operation of that influence is baffling, in large measure because teachers as a professional group have not attained and really do not need to attain the comparatively close-ranked unity and self-regulation which, for example, the legal profession maintains.

I make these last comments not at all for the mere purpose of listing some more professional groups, but rather because they are significant in connection with the question of assumption of professional responsibilities by scientists and engineers. The general question implicit in our review of the dilemma of the professional man is now squarely before us. Natural scientists — physicists and chemists in particular — who in the past have been primarily concerned with the perpetuation and extension of knowledge and so have been more scholars than professional men, are now reaching the status of a profession. Engineers, who have had professional consciousness as a group for a considerable period and have expressed it

Ewing Galloway, N.Y.

Government by the people is really government by that portion of the people which takes the trouble to participate actively in the forming of public opinion. It is this fact which explains the feeling of responsibility for discussion of public questions and for sincere consideration of them — the feeling that every thoughtful man has experienced.

through their continued efforts to develop an agreed code of ethics, encounter some difficulty over professional status because of their linkage into the economic and industrial structure. Yet I believe it has come to be recognized that science and engineering are professions, although not all scientists and engineers are professional men.

Why this development? There are many reasons, but for our present purpose we need cite only the most plain and direct of them. The esoteric equations of the mathematician and physicist of but a few years ago have, as extended by further research, by applied science, and by technology and engineering, become a matter on which the future and the fate of mankind depend — the reality of the release of atomic energy. Here, in the dispositions which the nations of the world decide to make in order to control or not to control a vast new force, the scientist is perforce brought out of his laboratory, for sound dispositions capable of assuring just and feasible utilization of this energy for the good of all men cannot hope of realization without his active help. Even if he wished, the physical scientist of today can no more cling to the isolated contemplation of knowledge than a romantic 14-year-old boy can go back to the days of Buffalo Bill. Rather, because of his special competence in a body of knowledge that has come to be a vital issue for the people as a whole — and mark you, that means not the people of the United States alone, but the people of all the world — the physical scientist is possessed of the authority and must accept the responsibility that mark the professional man as distinguished from the simple scholar.

In passing, let me observe that this last assertion is well substantiated by the fact that in the United States science as a professional calling and scientists as professional men are asking of the people the special consideration and the special position to which none but the professional can rightly lay claim. The legislation by means of which the public would establish a National Research Foundation — legislation on which I have strong convictions — insofar as it confers on science and scientists a special relationship to the rest of American life, justified by their disinterested contribution to the whole of American life, marks the coming of age of science as a profession. It is for us as scientists and engineers to realize to the full that sharp and often onerous responsibilities accompany that special relationship.

As we do so — as we undertake to meet the responsibility of professional men to contribute as best they can to the formation of public policy — we encounter the same dilemma that other professional groups have met. It is assured that we shall exert a long-range indirect influence and that we will pay sincere heed to it. Shall we superpose on it efforts at direct action, and if so, how far shall we go in this direction? There are degrees in direct action, and the crux of the problem is to make sure that the desire to help speed a social advance shall not carry us to a point in direct action which in the end will mean a net loss to society. How far in direct action can the scientist as a professional man go without unduly hazarding the disinterestedness which makes him a valuable member of the community? The classic divergence of views of government in the days of Alexander Hamilton and Thomas Jefferson is recalled in the implications of this question. As I see it, for all the value that direct action often has to recommend it, direct action, in a social and economic structure so complex and so intricately cross-connected as ours, can be very dangerous. (*Continued on page 586*)

William M. Ritton

We have, within the month, seen this whole mighty nation brought to the very verge of impotence and frustration by the extreme action of a single small group in its population.

"Good Earth" Photo by S. M. Hall

Applications of Science to Food Production

Promoting Peace or Unrest, the Supply of Food is Measured by the Extent to Which Technology is Employed in Food Production Rather Than by the Area of Cultivated Soil

By Henry A. White

THE technology of international peace, it can be assumed, has as its primary objective the elimination of the fundamental causes of war. These causes, in large measure, can be attributed to the primitive instincts of man, the most portentous of which are greed and need. If success in building world peace is to be achieved, the legitimate wants of man, or in the aggregate the basic needs of nations, must be satisfied within reasonable bounds. Efforts in this direction should include improving production methods so as to make available to the greatest number adequate quantities of quality product at reasonable prices.

The world today, having passed through one great crisis, is now facing another. Famine haunts many countries, and its threat falls heavily over many more. History reveals, almost to the point of monotony, that hunger, or the fear of hunger, is one of the primary causes of war, as well as one of its principal results.

All that might be said about this condition would be but a repetition of what one reads daily in the press and hears by radio. None can fail to realize that starvation, undernourishment, and malnutrition represent serious obstacles to world peace. Food is an essential in the preservation of life, in the prevention of disease and in nurturing the minds of men; therefore it is one of the strongest instruments for peace. A program of plenty, if aggressively prosecuted and designed to take advantage of approved scientific methods and modern equipment, can be a powerful factor in relieving the world of hunger, removing unrest due to this cause and promoting well being, prosperity, and peace.

Production of food in the United States reached an all-time high in the last six years. By way of comparison let me point out that in World War I farm production reached a point only nine per cent above its pre-war level. In World War II farm production increased 33 per cent over the pre-war average and was achieved with five million fewer farm workers than in 1940.

From this record of food production during the war and because of our current role in supplying world needs it would appear that, in addition to assisting in the present emergency, there is a continuing responsibility placed

An agricultural program would not be complete if it did not have as one of its objectives the preservation of good soil. . . . In contour farming the fields are designed to channel the heavy rains into slowly flowing rivulets, conserving at one time both the invaluable top soil and the badly needed moisture.

Photo from Hawaiian Pineapple Co.

upon America for future world production of foods. That responsibility is not solely one of feeding the peoples of the world or of continuing to tighten our own belts in order that others may eat. Such an approach does not strike at the root of the problem. There will always be demands for export of our surpluses, but a more realistic approach to the solution of world food problems would require us to make available to other nations knowledge that we have acquired in the science and technology of agriculture and the processing of foods.

Over the long run, and starting at once, home production of foods must be stimulated in each of the devastated nations — a normal commerce in foods must be reinstituted. In this momentous task the talents of all qualified men must be brought into play; the engineer and the strategist, the geneticist and agronomist, the financier and economic geographer — each must bend his shoulder to the burden.

Let us examine for a moment the reasons for our ability to produce foods in substantial volume. In addition to advantages bestowed by nature itself they are largely due to improved technology, to more intensive and specialized use of the soils, to increased mechanization, and the application of science to food growing and processing.

To a considerable extent we have changed from a nation of diversified, small production farms, to a nation in which each region contributes that which it can produce most economically, with operations being conducted on a larger and more intensified scale. Cattle, wheat, citrus fruits, cotton, truck vegetables and other crops — all are raised in larger volume in those areas where environmental conditions are most advantageous for each. As an example, the islands of Hawaii, unsuited for large-scale production of temperate zone crops, have become mass producers of two subtropical products; sugar and pineapple. Here again selection of areas for each of these crops is influenced by factors of topography, elevation, climate and water availability which affect quantity and quality of yields and economical production.

During the war marked progress has been made in the use of mechanical equipment on farms throughout the United States. For example, farm machinery purchased last year amounted to approximately $1,000,000,000 in contrast to annual purchases immediately prior to the war of about half that amount. The use of tractors increased by one-third during the war year; grain combines by about 75 per cent; corn pickers 50 per cent; and milking machines by 100 per cent. It is also interesting to note that in 1929 less than 10 per cent of the farms were electrified, while today more than 45 per cent enjoy the conveniences of electricity.

As a result of expanded and more intensive cultivation, the use of fertilizer showed a substantial increase during the war. The value of soil conservation work has gained recognition, but there is much to be accomplished in this field in the interest of preserving soil fertility. Notable work has been done in the application of fertilizers, in pest control, in land reclamation, in plant genetics, in nutritional control, in weed control, in by-product recoveries and in other fields. Great progress has also been made in mechanization — today machines do most of the hard work that once caused men to leave the fields.

This latter development does not mean that farm workers are being deprived of their jobs; rather does it mean that their daily chores are being lightened, and that farm life is made less burdensome and more attractive. Mechanization of farms will serve as a means of attracting labor back to the farm with a consequent increase in food production and lower food prices.

It is these scientific and technological advances — which, relatively speaking, are only beginning to be developed — that offer hope for ultimate alleviation of world food problems. Illustrative of achievement in meeting the challenge of present conditions are some of the

accomplishments of corporate agriculture in the Territory of Hawaii. It is doubtful whether there is any section of the world that has a higher level of agricultural efficiency, measured in terms of crops produced per square mile of arable land, or where the application of science to agriculture is practised to a more effective degree than in Hawaii.

Since my work is in the pineapple industry, I am taking the liberty of giving you a brief description of cultural practices and of citing technological progress made in agriculture in this industry.

Pineapple culture is unique. It is one of the newer food industries of the world and prior to the founding of the Hawaiian Pineapple Company in 1901, commercial pineapple production was insignificant. Hence, no prejudices and few precepts were inherited and at every turn there were problems to whet imagination and test ingenuity. Among the early tasks was the problem of unravelling the nutritional requirements of plants. It seemed incredible that some of the finest lands yielded the poorest crops — until it was learned that the pineapple plant needs large quantities of iron. It is a strange anomaly that iron salts must be sprayed regularly upon pineapple plants, the roots of which feed in soil containing as much as 20 per cent of their weight in iron.

Pineapple in Hawaii is cultivated under four or five year cycles, that is to say, the fields are planted every four or five years. About 20 months after planting, the first fruit, known as plant crop, matures and when harvested, preparations are begun for the second or ratoon crop which will ripen a year hence. Not to deal in technical terms more than is necessary for clarity, let me mention three parts of a growing pineapple plant. The top of a fruit itself — the green shoots — is known as a crown. Just below the fruit itself is an off-shoot of the fruit-bearing stem, or slip, which contains a complete root system. Below the slip are additional off-shoots called suckers.

At about harvest time field workers remove all the slips and also may remove all but one or two of the suckers from each plant. Slips are generally used as planting material for the succeeding crops, but under certain conditions crowns and suckers are also used. The original stem itself fruits only once, but each of the suckers, the off-shoots of the stem, may bear a pineapple the following year. Then the plants usually are knocked down and preparations are made for a new planting. Sometimes, however, the plants are allowed to stand for still another year to bear a second ratoon crop, and this is what is known as a five-year cycle of cultivation.

The number of slips planted varies, ranging from 14,000 to 18,000 per acre. It is customary to plant the slips through mulch paper which serves to control soil temperatures and weed growth and to retain moisture in the soils. However, experiments are now being conducted in the use of abandoned pineapple plants as a mulching medium, and the results to date are promising.

Just prior to the harvesting season, a pineapple crop approaches a volume unbelievable to the uninitiated. The annual crop is measured in the hundreds of thousands of tons, and a very substantial portion of the fruit ripens during a short period of time — approximately 12 weeks.

As you probably know, agriculturists have made great strides in the control of pests that attack the superstructures of plants, but little had been done to control the millions of organisms that attacked the substructures. Nematodes — microscopic eel-like worms — have been especially destructive to plant life over the entire world, and there are wide assortments of other plant enemies, such as insects, bacteria and fungi, which have escaped man's war on predatory destroyers of plant life.

Nematodes are particularly destructive to pineapple plants. However, we were able to remedy this condition with the use of a soil fumigant which can be produced cheaply enough to permit its widespread use in agriculture

Home production of foods must be stimulated in each of the devastated nations; a normal commerce of foods must be reinstated. In this momentous task the talents of all qualified men must be brought into play; the engineer and the strategist, the geneticist and the agronomist, the financier and economic geographer — each must bend his shoulder to the burden.

Photo by William M. Rittase

over the world. The product most commonly used is known as DD, a by-product of petroleum refining, and large-scale producing units are in operation in California and Texas. There is every indication that it will not only produce healthy crops where scrawny ones grew before, but that its benefits will extend to the vegetable and flower gardens of the suburbanite. Other synthetic chemicals having the same characteristics are now being marketed, or are in process of development. Chloropicrin (a form of tear-gas) has also been used in Hawaii as a soil fumigant, but its use is limited because of its higher cost and the hazards involved in its application.

By introducing small quantities of this volatile liquid, DD, into the soil, it is possible to kill nearly all of the subterranean organisms that attack the root structure, stunt plant life, and reduce yields. In badly affected areas we have increased pineapple production from 10 to 20 tons an acre by soil fumigation and there are vegetable gardens in the Islands which have doubled their productiveness. Government tests over the country have confirmed these results.

Individuals familiar with conditions estimate that through the use of this low-cost fumigant, some two million acres of land in the Southern States alone can be made productive again. Similar reclamation in other parts of the world, where soil has become too badly infested to make farming profitable, can likewise be brought about. Of course, the effect of such measures on food production is obvious.

The use of hormones for the control of fruit ripening is another significant development. There was a time when the magnitude and spread of the pineapple harvest was solely dependent upon factors of environment over which little control could be exercised. Now research has produced a chemical that makes it possible to have fruit almost at will. Widespread application has been made of alphanapthaleneacetic acid and related hormones. Two or three teacups, applied in water solution, will force flowering of the nearly two million plants on 100 acres. The application of these chemicals has no measurable effect on the quality of the resulting fruit but serves only to change a vegetative plant into a fruiting plant.

The use of hormones for retarding the ripening of fruits already formed has also been carried on with some success. Experiments to date have shown that, in addition to holding the pineapple "on ice," so to speak, the size and weight of the fruit can be increased. However, caution must be exercised in the selection of the particular type of hormone used for this purpose so as to obviate disruption of normal physiological functioning of plants which is essential to fruit quality.

Another utilization of agricultural chemicals is the mechanical application of chemical weed sprays, which has supplanted, in large degree, the tedious time consuming hand weeding of earlier eras. Mixtures of diesel oil and water, emulsified by using fish oil soaps or other suitable agents, are employed for this purpose. To the emulsions are added chlorinated phenols which are said to "activate" the mixtures herbicidally. Such mixtures are broadcast by sprays upon the young fields, prior to active growth of the pineapple slips. To prevent damage to plants and fruit, during later stages of the pineapple development, the sprays are used in conjunction with mechanical cultivators between the pineapple beds.

Other examples might be given of the way in which chemicals are being used to contribute to better and more abundant pineapple crops, lower costs, and greater land use. In addition, our laboratories, and those devoted to the improvement of other crops, have many interesting developments now in the experimental stage. Those cited illustrate the progress made in this field, however.

Giving due weight to improved agricultural technique just referred to, an agricultural program would not be complete if it did not have as one of its objectives the preservation of its most vital requirement — good soil. Being appreciative of the value (*Continued on page 606*)

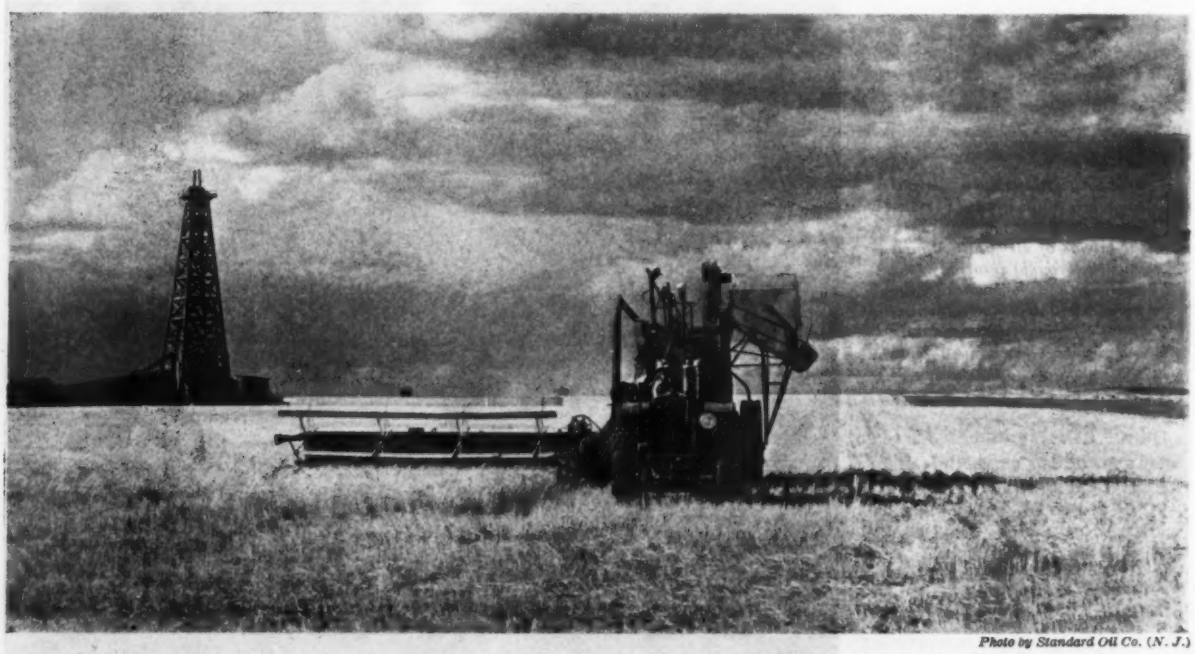
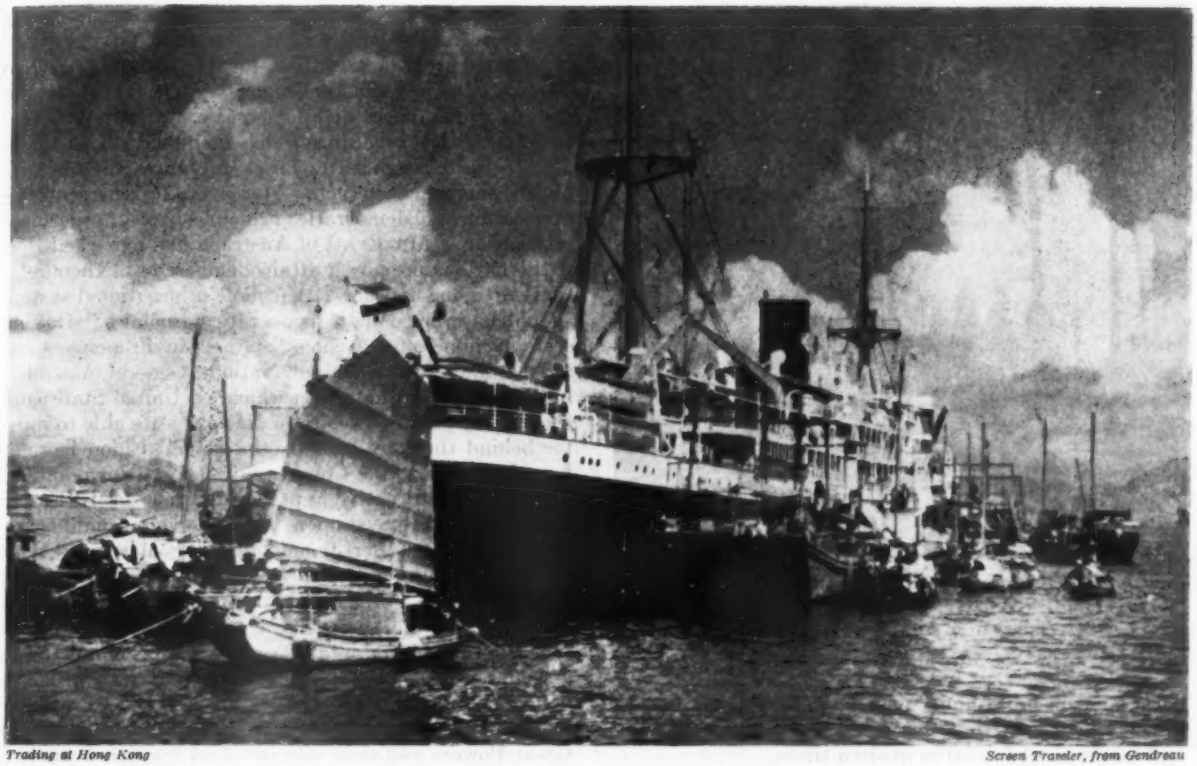


Photo by Standard Oil Co. (N. J.)

Our responsibility to our neighbors . . . is to pass on the fruits of our technology in order that they may stand on their own feet.



Trading at Hong Kong — *Screen Traveler, from Gendreau*

International Relations in a Scientific Age

Progress Requires Research, Technology, and Efficient Government. Scientific Personnel, Trained in International Affairs, is Needed to Pioneer in Human Relations

By Norman J. Padelford

IT is no exaggeration to say that, notwithstanding the logic and orderliness of science, we are living in a confused and troubled world. For all of their contributions to mankind in the improvement of standards of living, the facilitation of communications, and the provision of a rich diversity of goods, science and technology have also contributed directly and indirectly to the unrest and conflict which are so apparent in the present-day economic and political scene. Likewise they have been instrumental in laying the basis for revolutionary changes in international relations which seem destined to affect the life, the business, and the safety of every man and every nation.

A large part of the unprecedented destruction wrought by World War II has been due to the application of western science to military weapons. Through the development of mass production, made possible by modern technology, labor conditions and foreign trade the world over have been widely affected. Moreover, as a result of modern industrial techniques, a rapid depletion of certain strategic and critical raw materials has been taking place. Furthermore, through the more recent developments of science, new power factors have been introduced into the relations between nations.

The technological revolution has benefited mankind economically. Frankness compels us to acknowledge, however, that it has at the same time complicated the task of government internally and political relations internationally. By increasing the interdependence and multiplying the contacts between nations it has increased the friction areas among them. By increasing the demand for certain scarce commodities it has augmented the competitions likely to lead to conflict between nations. It has made the adjustment of political difficulties more delicate. It has necessitated faster action in dealing with crises. Above all, it has magnified the physical power of the national state while human and political power remain much the same.

It is at such a juncture that international peace must now be made. Of all the peace settlements in modern history, the present one is the most epochal. Raymond Fosdick has said that mankind now faces "its last chance;" that 1946 is "the most crucial year of western civilization." Whether the choice has been narrowed

Photo by Stanley Wilt

down to such finite limits may be debatable. It is conceivable, however, that the next twenty-five years may well be the most fateful in modern times.

There are certain extraordinary circumstances surrounding the determination of international relations at the present time. For the first time in modern history there is no truly Great Power on the continent of Europe. There are only three Great Powers, in the sense of decisive military power, — one in the new world, one quasi-Asiatic, and the third a loosely knit world-wide commonwealth with one of its focal points located in the British Isles. World peace hinges in large measure upon the actions and the relationships of these three super powers. If they agree and concert their efforts international peace can be assured. If they fail to agree there can be no world organization, worthy of the name, nor can there be lasting security. If they collaborate through the United Nations, or any other world organization, economic welfare can be improved and standards of living everywhere can be raised. If they cannot cooperate, constantly mounting proportions of national economy must be earmarked for war purposes.

A second circumstance of serious import at the moment of facing toward international peace is that new physical and political powers have been acquired by the three Great Powers at the same time that suspicions and conflicts between them have been multiplied. This is a portent both of difficulty and of danger. It complicates the task which has had to be assumed by the three powers never before brought face to face with each other for such a responsibility as victory in World War II has thrust upon them.

In preparing the peace, three alternate procedures have been possible. The first of these is the establishment of the peace by a Great Power directorate. Under such a procedure the Great Powers would draw up and enforce the treaties of peace. This is the method which the Soviet Union would prefer to follow. In a way, this is readily understandable for it corresponds with the Presidium idea in its own form of government.

A second procedure would be for the treaties of peace to be negotiated in a general Congress of nations. This is the method which the smaller democratic states would prefer to follow. It is a procedure which would have been agreeable to the United States for it minimizes the obstacle of the single nation veto. Moreover, it represents an application of democratic principles to international relationships. Mr. Evatt of Australia has remarked that if the nations intend to attain democracy in their relations with one another, "the whole international system should be imbued with democratic principles." Having seen on numerous occasions, at the San Francisco Conference and at the United Nations General Assembly in London, the voting power which the United States and the British Commonwealth of Nations were able to muster behind their leadership, the Soviet Union has not been favorable to the Congress idea, up to this point.

The third alternative in preparing the peace is the one which has been agreed upon. This involves a combination of Great Power leadership and a peace conference. Under existing arrangements the treaties of peace are being drafted by the Foreign Ministers of the Great Powers which signed the surrender agreements. When agreed upon by these representatives, they will be submitted to a conference of all states which were at war with the defeated states, much as the Dumbarton Oaks Proposals for an international organization were first drafted by the Great Powers and then submitted to the San Francisco United Nations Conference.

Thus far, the efforts of the Great Powers to re-establish peaceful international relations have not been successful. The Council of Foreign Ministers had made distressingly slow progress on the treaties with the satellite states, and wide area of disagreement continues to exist between the Foreign Ministers of the United States, the Soviet Union, Great Britain and France over certain fundamentals of the peace. At the same time, fairness compels us to recognize that the issues involved in making international peace are exceedingly complex, and that negotiation between the Great Powers is a laborious, time-consuming process. Many persons have been inclined to minimize the difficulty of the problems involved and the time required to reach satisfactory agreement upon them. Treaties of peace are designed to fix a status quo for a long period of time. The issues tied up with them must consequently be weighed with care.

To date, the Foreign Ministers have spent two months in session trying to draft the treaties of peace with Italy and the Eastern European ex-enemy states. Compared with the time spent in previous peace negotiations this is very brief. In 1919 President Wilson personally spent five months at the Paris Peace Conference negotiating with the principal allied and associated powers on the treaty of peace with Germany. Even after this treaty was completed a full year of negotiations between the Foreign Ministers and then the Conference of Ambassadors was necessary to reach agreement on the treaties of peace with Austria, Bulgaria and Hungary. The treaty of peace with Turkey was not concluded until four years after the end of World War I.

Candidness makes it necessary to add a word of caution. There may be some fundamental issues of principle involved in framing international peace today upon

which the Great Powers will not be able to reach entire accord without one side giving in completely to the other. Although there are few occasions in world politics in which any Great Power can have all affairs arranged as it believes best, there may be some principles in the present situation which neither side may be prepared to sacrifice. Consequently, further time may have to be allowed for negotiations, or arrangements made which will not seem altogether satisfactory to all concerned. In any event, agreement can be reached only if there is good will and a genuine disposition on all sides to cooperate toward the achievement of common objectives.

If the Foreign Ministers fail to agree at the next meeting in Paris, or in subsequent gatherings, what other courses are open? There would appear to be three possible moves which might be attempted: (1) the calling of a general peace conference; (2) the conclusion of separate peace treaties; (3) reference of the problem to the United Nations General Assembly.

Difficulties are apparent in each of these proposals. If one of the Great Powers is unable to agree upon certain terms of peace in the Council of Foreign Ministers it is conceivable that this same country would find it equally difficult to agree upon those terms in a general peace conference — if that country should be present. A formidable show of opinion might be mobilized in such a conference, and an objecting party might bow to the general will. On the other hand, unless some understanding could be reached among the Great Powers in this process the conference might extend the existing rift. The experience of the years between 1920 and 1945 should still be vivid enough in the minds of all to warn against the dangers which will arise if the powers which won this war fall apart as did the coalition at the end of World War I. The discovery of some formula for unity among the Great Powers is essential to peace and security.

To try to conclude separate peace treaties might prove to be very difficult. The western nations might be able to conclude a treaty of peace with Italy, and the Soviet Union might conclude a peace with the defeated nations in Eastern Europe. But the iron curtain already suspended across Central Europe might descend so completely that the western nations would find it impossible to conclude treaties with Bulgaria, Hungary, Roumania and Finland.

If the inability of the foreign ministers of the Great Powers to draft the treaties should be referred to the General Assembly of the United Nations, what contribution might this body make? Under the terms of the charter the General Assembly would not have the authority itself to undertake the writing of the treaties of peace. Moreover, any difference among the powers which had not been resolved in the Council of Foreign Ministers, or in a peace conference, would certainly appear in the General Assembly as well.

On the other hand, under its powers of discussion and recommendation concerning "general principles of cooperation" or "questions relating to the maintenance of international peace and security" (Articles 10–11 of the United Nations Charter), the General Assembly might be able to offer valuable suggestions for circumventing an impasse in the peacemaking.

Under Article 13 of the charter, the General Assembly might initiate studies and make recommendations for the purpose of "promoting international cooperation in the political field." Under Article 14 it might recommend measures "for the peaceful adjustment of any situation, regardless of origin, which it deems likely to impair the general welfare or friendly relations among nations," and it might call the attention of the Security Council to the situation.

Although the General Assembly would undoubtedly encounter opposition if a stalemate among the Great Powers were referred to it, nevertheless it might prove to be the salvation of the peace and demonstrate its preeminence among the organs of the United Nations.

On the whole, given the area of agreement already attained among the statesmen, and a generally apparent desire on all sides for the establishment of international peace, there are grounds for hope that with time, patience and vision, agreement may be reached upon treaties of peace with Italy and the smaller ex-enemy states in the not too distant future. Having explored their differences in the work upon these treaties, the Powers will then be in a position to commence consideration of the treaties with Germany and Japan.

Agreement upon the peace treaties must not blind us, however, to two things. In the first place, there may remain among the Great Powers certain antithetical concepts of international relations, and certain conflicting political and economic aims, which will afford fertile soil for future differences, making the path toward permanent peace difficult. In the second place, there may well continue to be a struggle for the balance of power within the United Nations.

Many persons, including a number of eminent scientists, have argued that the United Nations organization cannot secure peace in an atomic age, and that it should be converted at once into a world federation endowed with "real" powers.

There can be no denial that in operation thus far the United Nations organization has fallen short of expectations. Nevertheless, the San Francisco Charter was not

Photo by Chester H. Pope, '09

Photo by Vachon, Standard Oil Co. (N. J.)

the lowest common denominator. It was the highest common denominator that could be obtained from the nations as a result of three years of laborious negotiation. Given what we now know, any attempt to revise the Charter at this time in the direction of a stronger organization would face the possibility of disaster.

World union can be attained only by consent or by coercion. The world has rejected coercion in overthrowing the Nazi menace. It would oppose coercive efforts by any other nation or group of nations. Consent can be obtained only on a basis of mutual respect and understanding. It took 500 years to reduce some 400 to 500 political entities in Europe at the end of the Middle Ages to the present 50 states. It is too much to expect that 50 nationalistic, suspicious states can be merged into one world union overnight. International affairs move with a gradualness to which we must school ourselves. Provided there is a common will to move forward in the long run toward a higher goal a small amount of progress at any one time may be preferable to the failure of more perfect schemes on paper. This was the viewpoint which was held by the Conference at San Francisco last year. It was recognized that the United Nations organization was far from perfect; that the Security Council, General Assembly and International Court of Justice were not endowed with all of the powers which they should have for most effective functioning. It was appreciated that there might be trouble with the Great Power veto in the Security Council. Nevertheless, it was the consensus of opinion that even with these shortcomings the organization might succeed where the League of Nations had failed, and that after the nations had gained experience in working together within the framework of the Charter as it was adopted, amendments might then be agreed upon, as in the case of the Constitution of the United States, to make a more perfect union.

Former Secretary of State Stettinius has recently and aptly said that the time has come "to put the engines of the United Nations at full speed ahead, not to stop in order to experiment with redesigning them." Given wholehearted support by the democracies and a moderate degree of cooperation among the Great Powers, the United Nations may yet render yeoman service to the cause of peace, security, and social advancement.

Analogies are dangerous things in human relations. Because federation has worked in the United States is no token it will work in "one world." There are factors in the relationships between the present sovereign states of the world which were never present among the colonies which formed the Union in 1789. Those who shun the use of analogies in the exactitude of the sciences should beware of their use in the inexact relationships of men.

Experience would appear to demonstrate that the form of international government is of less consequence than the determination of states to settle disputes peacefully and to regulate international affairs by common action. If the United Nations cannot be made to work today, world government could not be made to work. If the United Nations can be made to work today, a stronger form of government may be possible tomorrow. What is needed above all is the discovery of some way of getting the United Nations to operate on a more internationalistic rather than multi-nationalistic basis. As one having a large stake in the success of the organization, the United States should search actively for policies and techniques which will promote the growth of the organization and unity among the nations.

Success in international relations in previous periods of time has depended primarily upon statecraft and military power. In the scientific age, success will depend as well upon organized scientific research, the maintenance of a large war potential of technology and industry, and an efficient form of government adapted to modern conditions. It seems a simple truth to say that the United States must find some way by which it can become a more disciplined democracy. Without going to the extremes of dictatorship, means need to be found whereby the strength of the nation will not be impaired by periodic labor and economic crises. Otherwise, the nation will not be able to fulfill its commitments abroad, and it runs the risk of being caught impotent in the event of an international emergency.

There are certain *sine qua nons* for the United States as it embarks upon its position of leadership in international relations in the scientific age.

Granting that there appear to be no immediate military threats arising abroad, nevertheless, the success of America's "peace offensive," as Secretary Byrnes termed it, as well as the safeguarding of the line against the further weakening of democracy by totalitarianism, point to the need of the United States having an armed establishment proportionately equal to that of any other Great Power, ready for instant action. Overseas bases should be maintained, not abandoned or deprived of their equipment, until all of the treaties of peace have been concluded, the procedure of the United Nations ironed out and the present differences between the Great Powers reconciled. Weakening America weakens the United Nations as well. Weakening the United Nations undermines the tenuous base upon which international peace rests.

(Continued on page 588)

Vermont Farm — *Photo by Irving Galloway*

Looking Ahead After 50 Years

Technology Provides Higher Living Standards Only When Man's Freedom and Dignity are Respected. Individual Freedom is Threatened When Control of Labor or Capital is Monopolized

By P. W. Litchfield

On the occasion of Alumni Day it has been customary for a representative of the class of 50 years ago to address you. This year that opportunity falls to the Class of 1896. All members of that class who are still living have completed the biblical span of three score years and ten. We can look back on a life full of personal experiences and observations of a great variety of world-wide events. Recalling the wise old saying, "Old age for counsel, youth for action," I hope you will pardon me if I turn your thoughts to serious matters for a short time.

During the Twentieth Century, which is now about half completed, there occurred the greatest progress in scientific and material development of any similar period in the world's history. The Massachusetts Institute of Technology, under the brilliant leadership of President Compton, has played a great part in this development.

As each of us grows older, time appears to go faster. The same is true for the world as a whole, for the tempo of life is a constantly quickening one. Progress in the material things of civilization is measured largely by advances in transportation and communication. If, as an example, we consider the advances which have been made in transportation, it is clear that the progress of civilization has been paced by the developing methods of transportation from foot to wheel to wing.

It happens that the Class of 1896 and the automobile — one of the greatest advances in transportation — began their careers together. I remember writing an essay on Winton's "horseless carriage" during my senior year. The Golden Jubilee 50th Anniversary of the automobile is being fittingly celebrated this month in Detroit. Although the past 50 years have been largely an automotive era, let us review briefly the progress of transportation throughout the centuries.

Centuries ago man went no farther nor any faster than he could walk. Development came slowly when the motive power on land was by domestic animal and on the sea by wind. Even under these conditions, however, empires were slowly built and the world was circumnavigated.

One hundred years ago mechanical power by steam was transmitted to the wheel and the great era of the railroad and the steamship began. Speed of travel increased from about 10 to 30 miles per hour.

This pace continued unchallenged until 50 years ago when development of the internal combustion engine, combined with the traction and cushioning of the pneumatic tire, made possible a new type of vehicle of quick accelerating power and free from the limitations of the inelastic, smooth, and level rail. The motor vehicle could operate over uneven surfaces and it could overcome steep grades; more important, the operation of each vehicle was independent of that of any other. During the last 50 years, which has seen the growth of the automotive era, speed of travel increased to 60 miles an hour or more.

Today we face additional changes brought about by that greatest invention of all history — the airplane — which fulfills man's desire for conquest of the air. No longer an earth-bound creature, man has carried transportation into the third dimension. The speed of transportation, suddenly increased to more than 250 miles an hour, shrinks the world to practically one twenty-fifth the size it was a hundred years ago. During the last 50 years, the automobile has made all of us neighbors within the nation and so during the next 50 years the airplane will make all mankind throughout the world neighbors.

Through the development of mass production, scientific management, and world-wide distribution of the products of industry and agriculture, the power to produce has been multiplied a thousandfold, enabling the earth to support an increasing population with a higher standard of living. The power to destroy has increased as rapidly as the power to produce, so that the product of years of civilization can be destroyed at one blow.

The destruction of physical tools of production and transportation, caused by the recent war, has created the greatest famine of all times. The cry, "Give us this day our daily bread" is the desperate prayer of millions of the earth's children.

We have just seen the greatest war in all recorded history, with countless examples of man's barbarous and cruel inhumanity to man. Instead of universal brotherhood we have witnessed an attempt by certain groups of men, to conquer and enslave others. America, although unprepared to meet this challenge, was large enough and powerful enough to supply the manpower and munitions to finally stop the slaughter and defeat this attempt to form a world superstate.

At home, however, we find reconversion to peacetime production is interrupted by nationwide strikes and class bitterness. It has been possible for the earth to provide a progressively improved standard of living to a constantly increasing population when the tools of production have been used efficiently by labor, and when all available knowledge of better processes and methods have had opportunity for practical application. Anything that stops this coöperation, causing idle or inefficient labor or idle or inefficient use of capital, stalls progress and encourages selfishness and greed. Instead of producing more wealth for everyone to share, men start to fight for a bigger share of what has already been produced, and civilization retrogresses.

As long as there is a fair division of the goods produced and each person receives a fair reward for his part in the production, harmony and progress prevail. As long as each individual is free to bargain for the use of his services or the use of his savings in a free and competitive market, the incentive for production is stimulated. Under monopoly or the subjugation of the individual to a dominant power, incentive to produce is decreased.

In a free country, wealth, honor, and power must be earned and must be shared and the widest possible range of opportunity must be provided for the public.

Currently there is a general feeling of unrest as to the national and international future. It seems to me that both situations have the same underlying cause and require the same remedy. Some of the lessons we learned at M.I.T. 50 years ago might well be applied today.

William M. Rittase

In its senior year, the Class of 1896 was fortunate in having two great teachers whose words of wisdom made a lasting impression on all our lives. One was Louis Brandeis, then a Boston lawyer, who later became an illustrious justice of the Supreme Court. He stood for the dignity and freedom of the individual, the protection of the weak against the aggression of the strong. He held that justice under law should overcome selfish force.

The other was our beloved president, Francis A. Walker, who gave us our course in political economy — the science of the production of wealth. He

(*Continued on page 596*)

ALUMNI DAY — JUNE 1946

The Technology of International Peace

Looking forward to World Peace, Harmony in Domestic Reconversion, and a New Era for M.I.T., Unprecedented Numbers Attend Alumni Day, June 8, 1946

DESIRE for tranquility was uppermost in the minds of Alumni and their wives who, after five years of war and one year of unsettled "peace," returned to M.I.T. on June 8, to view exhibits illustrating the Institute's part in World War II, to listen to three outstanding papers of a symposium devoted to "The Technology of International Peace," and to convene for the well-known Stein-on-the-Table Banquet. Missing from this year's activities were members of the graduating class for, as a result of the disarrangement of usual class schedules by the war's accelerated courses, there were no commencement exercises in June. Degrees were conferred on 220 members of the Class of 6–46 in informal ceremonies in Walker Memorial on June 14. Notwithstanding the absence of a new crop of graduates, however, Alumni Day was attended by record numbers. The banquet set an all-time high with an attendance of 1300, representing a gain of 58 per cent over last year.

Those taking part in Alumni Day activities bore an air of optimism and hope such as has not been evident since the latter part of the last decade, and good fellowship was the order of the day. Nevertheless a note of seriousness was injected by the realization — which found emphatic expression in symposium and banquet addresses — that individual freedom is threatened whenever and wherever selfish and powerful minority groups engage in monopolistic tactics, or attempt to place their own welfare above that of the nation.

Exhibits

AFTER registering in the main lobby of Building 10, Alumni and their friends had the morning free for visits to members of the faculty and staff or to the Institute buildings, which have undergone considerable expansion during the war.

Under the guidance of Herbert L. Beckwith, '26, Chairman, the Exhibits Committee organized and had on display numerous exhibits featuring the activities of the departments and laboratories. For many alumni, June 8 provided their first opportunity since the war's end, to return to M.I.T. and with this thought in mind, exhibits were planned to outline some of the highlight activities which transpired at the Institute during the war.

Clinic Dedication

AT 11:45 A.M., ceremonies were held for the dedication of the William R. Kales Eye Clinic in the Homberg Memorial Infirmary. The new clinic is a gift from Mrs. Kales in memory of the late William R. Kales, '92, who was a life member of the corporation. Mrs. Kales and her son, Robert G. Kales, '28, were present at the ceremony at which President Compton spoke of the value of this educational service in the Institute's medical program for the benefit of students and members of the staff.

Dr. Thomas Cavanaugh, who is in charge of the eye clinic, explained the purpose of this medical service and the equipment used in eye examination.

Among those present were members of the Medical Department Visiting Committee, including W. Cameron Forbes, William J. Mixter, '02, Samuel C. Prescott, '94, Reginald H. Smithwick, '21, James H. Means, '06, and John F. Gile. The Class of 1892 of which the late Mr. Kales was a member, was represented by Charles E. Fuller, Harry J. Carlson, and George H. Ingraham.

Members of the M.I.T. medical staff who attended the dedication were Dr. George W. Morse, director; Dr. John W. Chamberlain, '28, assistant director; and Lawrence B. Anderson, '30, and Herbert L. Beckwith, '26, the architects who had charge of the recent remodeling of the medical department.

When the hour was noon, groups began assembling in the du Pont Court for the buffet luncheon. Special tables were reserved for the 25-year and 50-year classes. Alumni of all classes intermingled in an informal atmosphere.

International Peace

AT the Institute, the day's events reached their peak in the symposium, "The Technology of International Peace," given in Walker Memorial. Charles A. Edison, '13, chosen as presiding officer, was unfortunately unable to attend, and his place was taken by George R. Harrison, who introduced the symposium speakers, Vannevar Bush, '16, President of the Carnegie Institution of Washington,

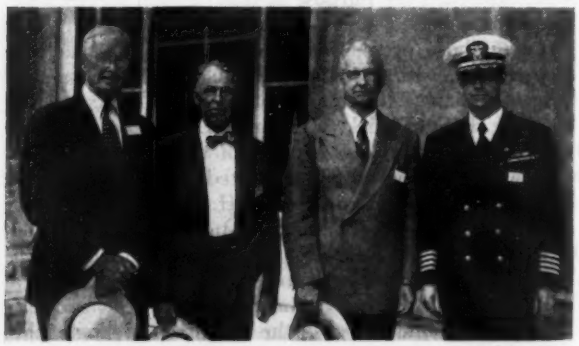
All photographs by M.I.T. Photo Service

President Compton, Mrs. William R. Kales, and Robert G. Kales, '28, at the dedication of the new William R. Kales Eye Clinic. The portrait of Mr. Kales, who was a life member of the Corporation, will hang in the Homberg Infirmary.

Henry A. White, President of the Hawaiian Pineapple Company, and Norman J. Padelford, Professor of International Relations. Dean Harrison's introduction was in light-hearted and witty vein, and by popular request is, in part, reproduced.

In substituting for Mr. Edison, I shall endeavor to adhere to the established rules of the Introducer's Union. Although the name of the first speaker is emblazoned on the program for all to read, it is not considered cricket verbally to specify his name until his topic and attainments have been properly set forth; then as a climactic thrill, his identity may be revealed in the closing words of the last sentence. Therefore without making any tempting reference to "beating around the bush," I shall outline some of his attainments, . . .

I suppose that this individual combines in his personality most of the qualities to which we of Technology like to point



Alumni Day provided opportunity for family and class reunions for the brothers J. A. Patch, '00, C. E. Patch, '02, R. R. Patch, '06, and Captain E. L. Patch, '10, left to right.

President Compton and Paul W. Litchfield, '96, engage in informal conversation during the luncheon in du Pont Court.

with pride when we say, "He is a Tech man." He has that shrewdness which has been dignified by the adjective Yankee, coupled with the imaginative insight, crusading zeal, and tenacity of purpose which we like to think of as typically American, and that gift of combining the tangential and the radial viewpoints which we know as humor. If the term did not already have other connotations, one could refer to him as a "Happy Warrior"; I must, under the circumstances restrain myself by calling him a "Cheerful Scrapper."

When two hydrogen atoms and one oxygen atom decide to combine to form a water molecule, they must have a nucleus on which to condense. Our first speaker, during the past six years, has furnished such a nucleus for the scientists of America. Without his catalyzing imagination the scientific contribution to the winning of the war would have been far less than the event has showed. If this were England he would long since have been knighted and baronetted, and would even now be Lord Bush of Barnstable, or some such personage . . .

In the morning the lobby of Building 10 was gathering place of those who wished to register or to meet friends and relatives, while . . .

I come now to the official revelation of the identity of this first speaker, and find before me the horns of a dilemma, or since there are three horns, a trilemma. Although I have known him for 16 years, as Dean of Engineering, Vice President of the Institute, chief of superchiefs in the Office of Scientific Research and Development, and inventive crony, and have called him by many names, I have never learned how properly to pronounce his first name. Since he speaks often, this is a situation which must confront many introducers, so I have had recourse to one of Bush's guiding tenets — "When you face a difficult problem which requires repetition, mechanize it at the start." I have therefore caused to be embalmed in a short stretch of verse the trilemma which I face.

'Tis said that Bush, before the war,
Was often known as Vanney Var,
Though persons every bit as clever
Were prone to hail him as Van Never.
Yet who shall call those ev'n naiver
Who introduce him as Van Neaver?

All this despite the fact that he
Signs letters with a simple V.
When Bush adds more it causes trouble
For all is indecipherable.

Van Never, Neaver, Vanney Var,
Whichever of these three you are,
Do not despise the cautious man
Who hails you forth as simply Van!

This may not completely solve our problem, however. A friend from Holland once protested bitterly against being called Van. "A Dutchman's name is Van Dyke, or Van Broeck, or Van Snorter. You do not call him Dyke, or Broeck or Snorter, you call him Van. Do you know what Van means? It means "of." How would you like to be called Of or From or Maybe? The present case, however, is different. Ladies and Gentlemen, I give you Van (and I don't mean "Maybe") Bush!

In usual order, Vannevar Bush, '16, J. R. Killian, '26, and Rodfield Proctor, '02, represent Corporation, Administration and Corporation.

. . . the ballroom at the Statler Hotel was filled to overflowing at the Stein-on-the-Table banquet in the evening of Alumni Day.

Dean Harrison's introductions of Henry A. White and of Norman J. Padelford were equally able, even though they were not based on so long a personal acquaintance as was the case with the first speaker. The Review is happy to publish, elsewhere in this issue, the three papers presented at the symposium.

Banquet

AS they had done many times before, loyal alumni gathered at Boston's Hotel Statler as the sun sank in the west, to spend a few hours of good fellowship at the Stein-on-the-Table Banquet. Ballroom facilities were taxed to the utmost in the largest banquet of its kind.

As toastmaster, A. Warren Norton, '21, President of the M.I.T. Alumni Association, introduced the honored guests and generally kept the banquet to the schedule established by hard-working committees. From time to time O. B. Denison, '11, led cheers or singing with the able support of George Wheeler, soloist, and Earl Weidner, organist. As usual, the steins, designed by Henry B. Kane, '24, and depicting good fellowship of the five allies became highly prized souvenirs of a gala event.

In recognition of his long and faithful service in caring for the health of students and staff, and for his work in building up the medical unit from a single physician's office to the present well equipped Homberg Infirmary, honorary membership in the Alumni Association was conferred upon Dr. George W. Morse, who was for 26 years, Medical Director at the Institute. In recognition of his war-time services, honorary membership was also conferred, in absentia, upon Lee Alvin du Bridge, dean of the Faculty of Arts and Sciences at the University of Rochester, and director of the Radiation Laboratory.

Professor Emeritus D. C. Jackson greets Mr. and Mrs. A. Warren Norton at the du Pont Court luncheon.

Assistant Class Secretary, Carole A. Clarke, '21, made the presentation of the gift from the 25-year class. Desirous of perpetuating the names of those alumni who have given their lives to attain the objectives of freedom during World War II, the Class of 1921 has agreed to underwrite a suitable war memorial to be selected by representatives of the administration and of the class.

Assuring us that the Class of 1896 was composed of "just average, run-of-the-mine alumni, without any of the prominent tycoons of some other classes," Charles E Locke, '96, presented a gift of $10,000 from the 50-year class. The gift of the Class of 1896 was made without any restrictions as to its use, and was accepted by President Compton.

Striking a serious note in commenting on this nation's post-war domestic reconversion, Paul W. Litchfield, '96, called for a return to those principles which were taught 50 years ago at Technology by Louis D. Brandeis, then a young Boston lawyer, and the Institute's former president, Francis Amassa Walker. Mr. Litchfield's address, "Looking Ahead After 50 Years" appears on page 565 of this issue.

Symposium speakers Norman J. Padelford, Henry A. White, and Vannevar Bush gave papers on the general theme "The Technology of International Peace" after being introduced by George R. Harrison.

William L. Campbell, '15, Alumni Day Chairman (right) entertains Mr. and Mrs. Henry A. White in the open air, informal luncheon.

A New Era

IN his annual report of progress, President Compton unfolded plans for a new era for the Institute which now faces the problem of providing educational and certain housing facilities for the unprecedented numbers of students who will study at M.I.T. in the next few years. That student housing has become a major administrative problem becomes evident when it is realized that most of the veterans who will study at the Institute

Left to right at the Ladies Table are: Mrs. L. F. Hamilton, Mrs. A. C. Cope, Mrs. Henry A. White, Mrs. George R. Harrison, Mrs. A. Warren Norton, Mrs. Norman J. Padelford, Mrs. Harold Bugbee, and Miss Julia Comstock.

are married men, many of them with families. The administration has already established Westgate Village which houses 100 married couples, and 500 additional students will be cared for in a temporary building erected during the war to house some activities of the Radiation Laboratory. Although such facilities will not provide the ultimate in desirable living, they will do much to relieve the already exceedingly congested residential areas in Cambridge. A new dormitory on Memorial Drive to house 200 students is among the eight new structures which have been approved for construction at an early date. Other buildings bearing top priority include a new library, a gymnasium, and five laboratories. Dr. Compton's address follows:

This is the first annual June banquet of the M.I.T. Alumni Association since the close of World War II. The role of the alumni, staff, and students of this institution in the war is well known and received high acclaim. There is no need for further recounting of past achievements. It is far more fitting that we now look ahead into the new era before us, and this large and enthusiastic alumni gathering may well mark the date from which we shall measure our achievements in the future.

In building for the future we have the firm foundations of the past. The basic objectives of the Institute, as set forth in its charter, are as important today as they were when this institution was founded almost exactly eighty-five years ago. These objectives of education, research, and cooperation with great technological interests of our country have not only stood the test of time, but the general development of our civilization has made them ever more important. Internally the institution is sound and vigorous; externally its reputation is high. We should therefore face the future with confidence and a virile ambition for still further improvement and achievement.

In my remarks to you, therefore, I shall briefly sketch some of our plans for this improvement and some of our ambitions which seem possible of attainment.

These plans naturally involve students, staff, programs of education and research, and facilities to implement these programs. Let me therefore divide my remarks under these headings.

Students

NO action of the Institute in recent decades has been more significant or more satisfactory than the adoption of the plan of stabilization of enrollment at levels deemed most advantageous for the over-all educational program, combined with the development of more skillful methods for the selection of students with fine cooperation of our group of approximately 200 Honorary Secretaries distributed in important centers all over the world. While subject to continual search for still further improvement, these procedures have proven so satisfactory that they will undoubtedly continue in operation.

Greatly increased pressure for admission of new students, and the fact that we were able during the war to make some significant additions to the permanent educational plant, have led us to increase our enrollment from about 3,050 to about 3,550 as a stabilized figure for the foreseeable future. During the emergency created by the return of veterans, however, we are admitting up to the maximum possible crowded capacity of 4,500, and this crowded condition may last for three or four years. This emergency increase in enrollment is done at a slight sacrifice in educational effectiveness, but at a very great sacrifice in convenience and in many features which promote long term effectiveness. These sacrifices are an unavoidable result of the war and are certainly justified. This suddenly increased enrollment creates many problems of housing, scheduling, and wholesome student life.

Our greatest deficiency, and hence our greatest problem and opportunity, in the handling of students, has to do with those environmental features which constitute what is generally called "student life." While some of our recreational facilities are excellent, notably the swimming pool, the sailing pavilion and its fleet of dinghies, and the track and track house, other recreational facilities, such as a gymnasium and tennis courts, are sadly inadequate. We have no little theatre or auditorium suitable for the student dramatic and musical clubs, which now carry on under handicaps only because so many students are enthusiastic about such avocational activities. The social facilities provided by the Walker Memorial are very inadequate.

During the informal luncheon the 25-year class had a special reunion table with sunshine and cafeteria service . . .

Counterclockwise from opening at the table seating early Technology graduates are S. S. Dearborn, '84, W. L. Puffer, '84, A. T. Chase, '86, F. E. Ellis, '88, S. E. Thompson, '88, Mildred Allen, '22, C. F. Allen, '72, G. W. Kittredge, '77, and F. F. Tripp, '87.

There is something more basic than these particular examples. Quite properly, in an institution like M.I.T., first consideration should be given to the efficiency and excellency of performance of its main objectives, — education and research. The slogan, "Technology is a place for men to work and not for boys to play," is wholesome and has much to commend it. It remains true, however, that much can be done rather incidentally, through cultural environment and provision of opportunities for extra-curricular activities, to develop those attitudes and traits of personality which are extremely important in molding an individual who will be successful and happy as a member of society. We need to give increased attention to these matters.

Staff

TURNING next to the subject of staff, my comments can be very brief and to the point. Taken either as a whole, or department by department, I can say with pride and good conscience that they are unexcelled anywhere in the world in professional competence, reputation, loyalty, cooperation, and industry. I know of no member of the staff who is not enthusiastic about his work and about his colleagues. It is a great joy to work in such an atmosphere. The deans, department heads, and departments as a whole, have been unremitting in their efforts to secure and to maintain staff of the highest caliber.

. . . whereas the 50-year class was accorded the honor of President Compton's presence, table service, and canopied shelter.

There are, however, two problems of staff which urgently demand attention. The first is that the staff is seriously overburdened and has been for a number of years. This is due in part to the limitations of budget, in part to the professional enthusiasm of the staff members themselves to undertake more and more work in their fields of interest, and in part to the frequently overwhelming demands on them to perform all kinds of good deeds for government, industry, or community.

The second, and even more urgent, problem is that of the general salary scale, all the way from the highest to the lowest staff grades and including the employees in the offices, shops and other services necessary to the operation of the Institute. In proportion to its prominence and the standing of its faculty, M.I.T. salaries have always been low. The problem is greatly accentuated at the present time by the increasing cost of living and by the increasing wage scales generally throughout industry. In common with other educational institutions, we are faced now with a real post-war emergency. Expressed baldly, the Institute needs more income. Unless this is secured, the finest of educational plans and plants cannot maintain its effectiveness or permit the successful handling of some of the fine opportunities which we see ahead. This problem should be the concern of every alumnus and every friend of M.I.T., and I personally ask for every help which can be given to meet it.

Programs of Education and Research

PROGRAMS of education and research are under such continual review that there are always many new things to report. Of necessity, however, I shall confine my remarks to three major trends which are beginning to play a very large role in our operations.

The first of these is the development of centers of research which coordinate the cooperative activities of various departments in certain very important fields of overlapping interest. While we call them centers of research because research is their predominant role, they are nevertheless destined to play a very important role in our educational program, especially at the senior and graduate student levels. Their influence will also filter back into the cooperating departments to enliven and modernize their programs in the direction of the very latest technological developments.

These centers of research appear to be a highly satisfactory answer to a problem which has long confronted us and other institutions, namely, that of handling those interests which reach outside the traditional departmental boundary lines and require the cooperation of the specialists and points of view of various departments. Certain institutions have tried to meet this problem by setting up special institutes; others have set up new departments. Both of these solutions seem to us to be weak in one important element, namely, the mobilizing of the interested personnel in various departments into a cooperative effort, while still recognizing each department's special interest in various aspects of the program.

(Left to right) Just arriving at the speakers' table are: C. E. Locke, '96, Secretary of the Alumni Association, William L. Campbell, '15, Alumni Day Chairman, Parke D. Appel, '22, Banquet Committee (partly hidden), Henry A. White, symposium speaker, Paul W. Litchfield, '96, banquet speaker, A. Warren Norton, '21, President of the Alumni Association, receiving instructions on operation of public address system from technician, R. F. Haffenreffer, '95, President, Technology Club of Fall River (behind microphone), G. R. Harrison, symposium chairman, Norman J. Padelford, symposium speaker, Dr. George W. Morse, Medical Director at the Institute and recipient of honorary membership in the Alumni Association, Harold Bugbee, President-Elect of the Alumni Association, and C. A. Clarke, '21, Assistant Secretary, 25-year class.

The Research Laboratory of Nuclear Science and Engineering represents an even wider distribution of interest, since it involves the Departments of Physics, Chemistry, Electrical Engineering, Metallurgy, Mechanical Engineering, Chemical Engineering, Biology, and probably others to lesser degree.

Both of these research centers are outgrowths of the great interest and increased tempo of research resulting from the war. Both are supported by very large funds provided by government, industry, and M.I.T. Both provide facilities for any member of the staff of the Institute who has a worth while problem in these fields. Both have, in addition, a staff of administrative officers, research associates, assistants and the necessary shop services. Both will offer very great opportunities to advanced students and staff.

The Center of Analysis for the development and use of a wide variety of automatic computing machines is the oldest of these centers of research. In a somewhat similar category, and more recent, are the Spectroscopy Laboratory, the Acoustics Laboratory, the Instrumentation Laboratory, the Servomechanisms Laboratory, the Committee on Applied Mathematics, the Laboratory for Insulation Research, the Industrial Relations Section, and the Research Center for Group Dynamics. To a greater or lesser extent these and others are tending to become specialty and coördination centers for methods or equipment which have a wide range of application. I look for this type of organization to become increasingly important as technology becomes ever more complex and artificial boundaries between the sciences break down.

A second major new development in our programs of education and research is the greatly increased degree of interest and coöperation of industry and of the War and Navy Departments. The work sponsored here by these outside agencies during the coming year involves a sum at least equal to the largest pre-war operating budget of the entire Institute. On the industrial side the contributions of a group of companies interested in food technology to our newly established Food Technology Department, and of a group of electrical, machine tool and aeronautical companies to our new program in gas turbine engineering are notable.

We are working on substantial contracts from the Bureau of Ordnance of the War Department and the Office of Research and Inventions of the Navy Department. These contracts can be wholly justified on an educational basis and also on the basis of real advancement of fundamental science and engineering art.

We believe that this type of program, which brings to the Armed Services the coöperation of educational institutions in solving their problems and in training personnel to increase the national strength in important fields, is wise and should receive every encouragement and support. We are coöperating with the Army and Navy in this effort whole-heartedly, although we have been forced to limit the number and magnitude of the projects which we could thus undertake in view of the limited capacities of our staff and facilities which are also urgently needed for the education of the abnormally large number of students.

The third feature of our educational program has to do with the greatly increased number of post-graduate students coming from the Army and Navy for training in certain specialties. For a great many years we have handled the post-graduate education of the naval constructors and, more recently, the combined program for naval constructors and naval engineers under the Bureau of Ships, through an arrangement with the Post-graduate School at Annapolis. In addition to this, before the war we had a few special military students coming to study such subjects as torpedo design or fire control. Now, however, and again as a result of the recent war experience, both Services are sending greatly increased numbers of selected young officers for post-graduate study in educational institutions. In fact, about one-third of our total post-graduate enrollment of more than 1,000 graduate students during the coming year will be composed of young Army or Navy officers. The demands on us for such educational assistance to Army and Navy have been heavy and well reasoned, and we have had to limit the number admitted only because of the importance of retaining an appropriate share of opportunity for civilian graduate students to be trained for professional careers in industry or education.

With this brief discussion of only three of the new aspects of our program of education and research, I pass on to discuss new facilities for implementing these programs.

New Facilities

PERHAPS you will find these to be the most interesting of our plans for the future, — interesting because of their specific and visible character.

At the alumni dinner last February I described our new building program and will not again go into detail at this time except to refresh your minds by mentioning the various items. Eight new permanent buildings have been approved by the Executive Committee and their construction given top priority. For some of them the funds are completely in hand and we are only awaiting completion of architect's plans to proceed with construction. For others the funds are partly in hand or the possibility of funds is at least in sight, so that we are also proceeding with the plans for them, in the hope that the financing may be complete by the time construction could begin. In all we need still some four million dollars to finance all items of this ten million-dollar program. *(Continued on page 602)*

THE INSTITUTE GAZETTE

PREPARED IN COLLABORATION WITH THE TECHNOLOGY NEWS SERVICE

Advancement

APPOINTMENT of Professor Thomas K. Sherwood, '24, as Dean of the School of Engineering has been announced by President Karl T. Compton. Professor Sherwood has been Deputy Dean of Engineering since last February as well as Professor of Chemical Engineering.

Professor Sherwood succeeds Dean Edward L. Moreland, '07, holder of the post since 1938, who asked to be released so that he might return part time to the Boston firm of consulting engineers, Jackson and Moreland, from which he has been on leave during the war years. Dean Moreland will continue at the Institute as Executive Vice-president, and in this part-time capacity he will act as consultant to the President and Vice-president on matters affecting Institute relations with government, on the coordination of sponsored research among the several departments and schools, and on the planning and provision of new facilities and revision of existing space required by the Institute's enlarged program of research and education.

"Dean Sherwood," said President Compton, "brings to this major administrative post at the Institute an exceptional combination of experience as a successful teacher, consulting engineer, and director of research. During the war he carried through a variety of important assignments for the Office of Scientific Research and Development which demonstrated his successful coupling of practical engineering with a fundamental scientific point of view."

As recorded in the March 1946 issue of The Review, which contains additional data on his career, Professor Sherwood was appointed Deputy Dean of Engineering in February.

Emeriti

SEVEN members of the instructing staff who have served the Institute as teachers for periods ranging from 19 to 48 years, will retire on July 1. The group includes Professor Charles B. Breed, '97, former Head of the Department of Civil and Sanitary Engineering; Robert S. Williams, '02, Head of the Department of Metallurgy, who acted as Deputy Dean of Engineering during the war; George W. Swett, '03, Professor of Machine Design and for many years secretary of the faculty; Carle R. Hayward, '04, Professor of Process Metallurgy; Matthew R. Copithorne, Associate Professor of English; and Johan Selmer-Larsen, lecturer on modeling in the School of Architecture and Planning. Robert C. Eddy, of the Division of Industrial Cooperation will also retire on July 1st.

Professor Williams, while retiring from active teaching duties, will continue to serve as Dean of Army and Navy students. He will have the rank of professor emeritus and honorary lecturer, as will Professors Swett, Hayward and Copithorne. Professor Breed retires with the rank of professor emeritus.

Professor Breed has been a member of the staff of the Institute for 48 years. He was appointed an assistant in civil engineering in 1898, a year after his graduation from the Institute, becoming a full professor in 1914, and was head of his department from 1934 until he relinquished that post in 1944. Professor Breed is a native of Lynn where he was born in 1875. He has been an advisor on construction and economic problems for a number of the country's leading railroad systems, as well as consultant for various state public service and public works departments. In 1939 Professor Breed, in association with two other engineers, completed a two-year study of highway costs for the Association of American Railroads. During World War I he taught navigation and aerial observation in the U. S. Army School of Military Aeronautics, later serving as president of the academic board of that school. In the recent war he was confidential advisor on transportation to the Army and to several railroads. He is widely known for his textbooks on engineering subjects.

Joining its staff in 1902, the year of his graduation, Professor Williams has been associated with the Institute for 44 years. He has served continuously since then except for two years when he went to Germany for advanced study at Göttingen. Upon his return to this country in 1907 he became an instructor in the Department of Chemistry. In 1924 he was appointed professor of analytical chemistry and metallurgy and three years later he was made head of the course in physical metallurgy. In 1937 he became head of the department of metallurgy, and from 1942 to 1945 he was on leave-of-absence from his department to serve as Deputy Dean of Engineering. He is widely known among students as the author with Professor V. O. Homerberg of the "Principles of Metallography."

Professor Swett, who is an authority on machine design, has long been secretary of the Institute's faculty and is widely known in engineering and educational circles. In addition to his duties on the Institute's staff, he has been a member since 1903 of the staff of the Lowell Institute School. Early in his academic career he was the first head of the mechanical engineering department of Northeastern University. He is a native of Troy, N. Y., and was graduated from the Cambridge Manual Training School, now Rindge Technical School, in 1899 when he entered the Institute from which he was graduated in 1903. He joined the Institute's staff in the same year and was promoted to professor in 1929.

Professor Hayward is a recognized authority on process metallurgy and has studied and written extensively in his field, particularly on copper, lead, and zinc. He has long been sought as a consultant in this field and assisted in developing the present process for producing oxygen-free copper. A native of Yankton, S. D., Professor Hayward was graduated from M.I.T. in 1904 and for two years was an instructor in science at Bellows Free Academy in

Fairfax, Vt., before joining the Institute's instructing staff. He has written and translated a number of books in his field and is the author of many technical papers on metallurgy. Professor Hayward is a former member of the Quincy City Council and has long been active in the work of the Y.M.C.A.

Professor Copithorne, a native of Cambridge, was graduated from Harvard University in 1912 and joined the Institute's staff in 1918 as an instructor in the Department of English and History. Popular among his students for many years, Professor Copithorne is widely known as a lecturer on prose and poetry.

Colonel Eddy is a former head of the Department of Military Science and Tactics at the Institute and a graduate of the U. S. Military Academy at West Point in the class of 1905. He is an honor graduate of the Coast Artillery School at Fort Monroe and in 1923 was graduated from the Command and Staff School at Fort Leavenworth. During World War I he served as a member of the artillery defense staff at Panama and in 1918 was ordered to Washington to take charge of the organization and training of heavy artillery units for overseas service. Upon his retirement from the Army, Colonel Eddy joined the staff of the Institute and served for several years in the department of business and engineering administration. In recent years he has held an executive post in the Division of Industrial Cooperation.

Mr. Larsen is widely known in New England as an instructor in modeling. He was educated in the Royal School of Art in Christiania, now Oslo, Norway, where he studied from 1902 to 1905. He joined the staff of the Institute's School of Architecture and Planning in 1922. Previous to that time he had been an instructor in the South Boston School of Art in 1912, the Cambridge School of Art from 1914 to 1916, and the Worcester Art School in 1921.

Cultural Exhibits

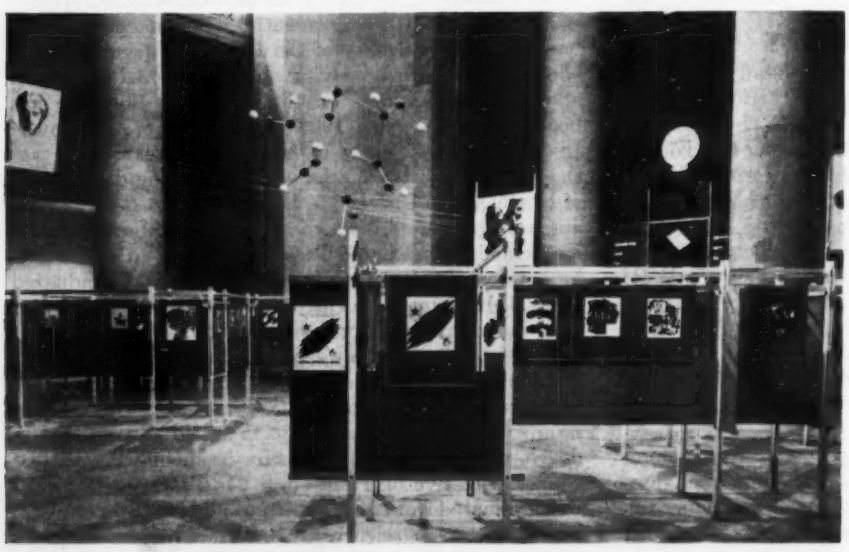
THE fruition of an ambitious plan for temporary exhibitions has taken place in the Institute's first postwar year. These shows represent one of the two facets of the present museum policy of M.I.T.

Under this plan, the staff of the Museum will continue to develop more interesting and complete permanent technological displays in spaces appropriate for such presentations. At the same time, it is recognized that permanent exhibits are of greatest interest to the occasional visitor, for members of the Institute family might be expected to develop blind spots to long-standing material, and hence a program for temporary exhibits is also under way.

The second and possibly more important part of the plan calls, therefore, for an increasingly vigorous display of a series of temporary and general nontechnological shows of approximately three weeks' duration and changed at intervals of about a month. These temporary exhibits are expected to add to the interest and variety of Institute life and, at the same time, to stimulate a group of observers, however small, to an increased interest in some facet of current culture. Thus they are to serve as an extracurricular adjunct to the formal program of the Division of Humanities.

It is no part of the plans of the sponsors that all of these shows shall please everybody; indeed, they are certain not to if they are well contrived, for only the most tasteless of viands can have the faculty of displeasing no one. It is not even a part of the expectation that they shall at times be able to escape the allegation of being propaganda, for it is hoped that the displays will have some influence on those who view them. The standards set are such that, in every case, the quality of the display shall be as good as can be produced today, and this quality is to be measured in terms of the material selected as well as in the manner in which it is shown.

It is expected that eventually the shows will be exhibited in a room especially designed for the purpose in the new library, but it is felt wise not to defer beginning this program until the completion of the new building. For the time being, therefore, the exhibitions have been placed in the lobbies of either Building 7 or Building 10. In its own way, each of these exhibition places has proved to be a remarkably effective show place. Each has the advantage, over any other Institute display space, that almost everyone passing through the Institute has to pass by the exhibitions — and few pass without stopping to



Of the temporary exhibits shown at the Institute during the past year, that on examples of modern advertising art caused most comment. Shown here is a portion of the exhibit which was on display during April in the Rogers Building. Art students from Boston and Cambridge were frequent visitors to this exhibition.

examine. Consequently, it is probable that these lobbies will continue to be used from time to time even after the new room is ready.

For a long time, of course, the Museum committee has sponsored traveling exhibitions, but on a very limited budget. This year the budget has been substantially augmented, and the committee has a new chairman in Professor Howard R. Bartlett, Head of the Department of English and History. Professor Herbert L. Beckwith, '26, who has returned to the Department of Architecture and Planning after his wartime leave, has been appointed director of exhibits, reporting to the director of libraries, who is administratively responsible for the entire program. The combination of increased funds and of skilled talent in the art of exhibitions has made for a richness never before achieved at the Institute.

The season opened on November 11 with a showing of dramatic photographs collected by the Navy during the war under the leadership of Edward Steichen. This show, "Power in the Pacific," opened simultaneously with the Institute's "Victory in Science" exhibit (described in the December issue of The Review), both of which were set up by Professor Beckwith. The group of Navy photographs was followed by an exhibition of stage designs, loaned by the Museum of Modern Art of New York, and by a collection of illustrations portraying industry and culture in India, provided by the British Ministry of Information.

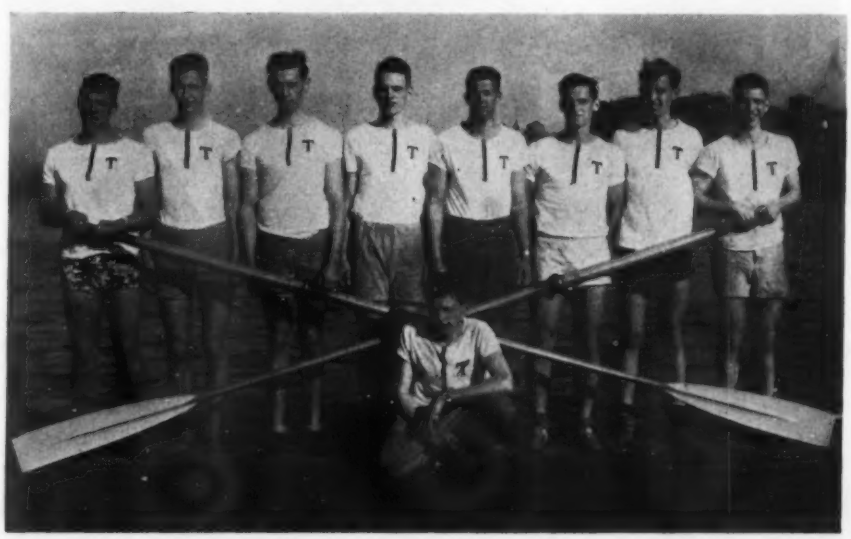
Beginning in February there was a series of notable exhibits, each of them a first (and most of them the only) showing in Boston, as had also been the case for "Power in the Pacific." The first of this series was an exhibition of maps prepared by the Hydrographic Office of the Navy during the war, which had been shown previously only in the Library of Congress. This exhibit was opened with a gallery talk by Guillermo Medina, principal engineer of the Hydrographic Office.

A colorful exhibition of painting on the general theme "Oil, 1940–1945" by the more conventional group of modern American painters was shown early in March. These paintings were executed, upon commission of the Standard Oil Company of New Jersey, by such well-known artists as Joe Jones, Frederic Taubes, Howard Baer, Adolph Dehn, Ernest Fiene, and Laurence Beall Smith. They had been shown previously only at the New York opening at the offices of the Standard Oil Company of New Jersey and from their showing at the Institute immediately were sent on national tour.

In April, pictures painted for the Container Corporation brought to the Institute examples of modern advertising art. This group of paintings was the work of such important artists as A. M. Cassandre, Fernand Leger, Herbert Bayer, Jean Hélion, and Gyorgy Kepes, who has but recently joined the Institute's staff in the Department of Architecture and Planning. Although this exhibit appealed less to the Institute public than some of the other exhibits, it attracted widespread interest in Cambridge and Boston. Several thousand visitors came to see this exhibit during its four-week run, and the 1,500 printed catalogues proved entirely inadequate for the demand. This exhibit of advertising art was used regularly as a point of study for groups of students from the art schools in Boston.

Between these two exhibitions of paintings was one of photographs of modern American architecture, entitled "Built in U. S. A." This exhibit, assembled by the Museum of Modern Art, was undoubtedly the most popular with Institute staff and students.

At the year's end, the final show was the most original of all. It displayed textiles as examples of art and science and was the result of a collection by Edward R. Schwarz, '23, Professor of Textile Technology, and his colleagues, with Anni Albers, distinguished artist and textile designer from Black Mountain College in North Carolina. Experimental textiles were shown along with pragmatic ones, including some from Professor Schwarz's collection of Peruvian pieces. The specimens were assembled directly from the designers, and every important designer in America contributed, including such well-known persons as Dorothy Liebes and Henning Watterston of San Francisco, Marianne Strengell and Robert Sailors of the Cranbrook Academy of Art in Bloomfield Hills, Mich., Marli Ehrman of the Institute of Design in Chicago, Else Regensteiner of the Art Institute in Chicago, and Anni Albers. This was a show originated at the Institute and one which will not be duplicated elsewhere.



On June 16 the M.I.T. varsity crew left Cambridge by plane for Seattle where leading crews of the country took part in the invitation regatta on Lake Washington on June 22. Members of the crew are, from left to right, John Banks, Paul Gerhardt, Albert E. Bowen, Jr., John E. Taft, captain, John R. Saxe, James Robertson, George Colville, and Robert L. Silberman. In front of crossed oars is John W. Leonard, coxswain. The M.I.T. crew came in second.

Corrosion Study

CORROSION of metals, cause of one of the world's greatest economic losses, will be studied in a co-ordinated program of instruction and research at the Institute, President Compton announced on June 14, with the appointment of Herbert H. Uhlig, '32, as an associate professor in the Department of Metallurgy to take active charge of the project.

In order to consolidate the attack on this major problem, which causes estimated losses amounting to several billion dollars annually, Dr. Uhlig will cooperate closely with all departments of the Institute concerned with corrosion. The subject has been under investigation at M.I.T. for many years and important work has been done by the Departments of Metallurgy, Chemical Engineering, and Chemistry. Organization of the corrosion program as a project on which the resources of all departments will be brought to bear is expected to expedite the search for methods of preventing or controlling corrosion. In the oil industry alone it is conservatively estimated that losses from corrosion amount to approximately $125,000,000 a year in refineries and $50,000,000 in pipe lines.

Studies of corrosion began at Technology with the notable work of Willis R. Whitney, '90, and William H. Walker in the early years of the present century. This was followed by important contributions by Professor Walter G. Whitman, '17, head of the Department of Chemical Engineering, and his associates, in the early 1920's. In the years that have followed, corrosion has been studied almost continuously.

Professor Uhlig graduated from Brown University in 1929 and completed his work for the doctorate at M.I.T. in 1932. After a year as physical chemist at the Rockefeller Institute he went to Lever Brothers as research chemist and became assistant chief chemist in 1937. He then joined the M.I.T. research staff to take charge of a project dealing with the corrosion of stainless steel. Later he was called to the Research Laboratory of the General Electric Company where he has been engaged in research on corrosion and allied problems. He has published a number of papers on corrosion and is editor-in-chief of "The Corrosion Handbook" to be published shortly.

Professor Uhlig, who joins the Institute's staff on July 1, is planning a fundamental research program with the study of the nature of metals and metal surfaces as its main objective. The problem will be attacked largely from the electrochemical viewpoint and is expected to lead to a more logical approach to the selection of corrosion resistant metals and to methods of production.

Laboratory of Mechanical Metallurgy

EXPANSION of its facilities for instruction and research in the field of engineering materials and establishment of a laboratory of mechanical metallurgy has been announced by President Compton.

Present facilities developed in this field by the Department of Mechanical Engineering will be transferred to the new center, which will be administered by the Department of Metallurgy. Dr. Compton also announced the promotion of Dr. John Wulff, Associate Professor of Metallurgy, to the rank of professor and the appointment of Howard F. Taylor as Associate Professor of Mechanical Metallurgy.

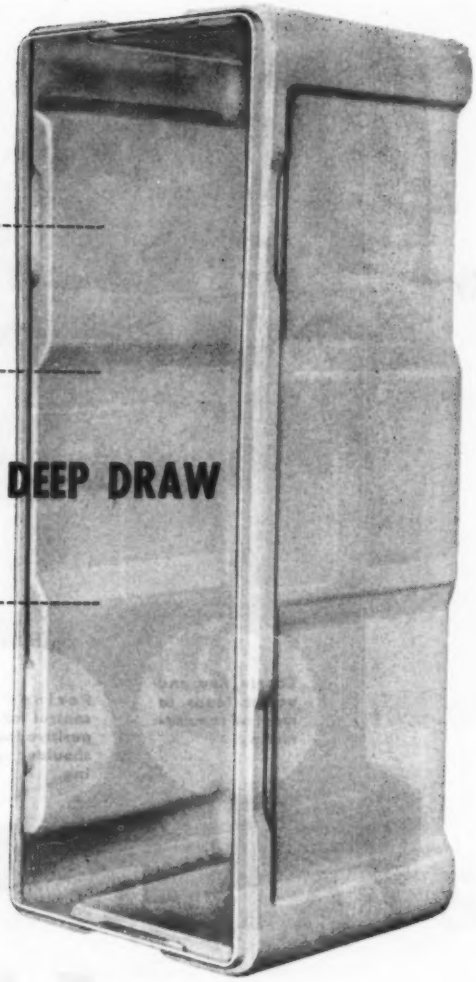
The new laboratory will be under the active supervision of Professor Wulff, and his staff will include Professors Edward L. Bartholomew and Frederick R. Evans, and Malcolm S. Burton, instructor. Cooperation in teaching and research will be actively maintained between the Departments of Metallurgy and Mechanical Engineering.

Professor Wulff will have the counsel of an interdepartmental committee composed of Professor C. Richard Soderberg, '20, of the Department of Mechanical Engineering and Professor John Chipman, head of the Department of Metallurgy.

In announcing the new center, Dr. Compton said that "the requirements of the gov- (*Concluded on page 582*)

For services rendered to the nation during the recent war, A. Warren Norton, '21, President of the Alumni Association was awarded a certificate of appreciation from the War Department at ceremonies in his office on June 12. The presentation was made by Major General Harry C. Ingles, Chief Signal Officer (left) and Colonel Jay D. B. Lattin of the Signal Corps.

FINAL, ACCURATE DIMENSIONS IN 1 DEEP DRAW



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Revere light metal products include magnesium sheet and plate, rod and bar, tube, extruded shapes, and forgings in all standard wrought alloys, as well as aluminum alloy tube, extruded shapes and forgings. A Revere Technical Advisor will gladly consult with you about the application of these products to your business. Get in touch with Revere.

Weighing only 5 lbs., this box 29" long, 11" wide and $10\frac{3}{4}$" deep was made of Revere magnesium alloy 0.081" sheet by Brooks and Perkins, manufacturing engineers, 2457 Woodward Avenue, Detroit, Mich. Produced in *one* draw on a 200-ton hydraulic press at a temperature of 550°F. An additional operation formed the shoulder at the top to receive the lid. Made to carry military rockets, these deep-drawn magnesium boxes suggest how readily magnesium can be used to lighten the weight of bus and truck body parts as well as numberless other products.

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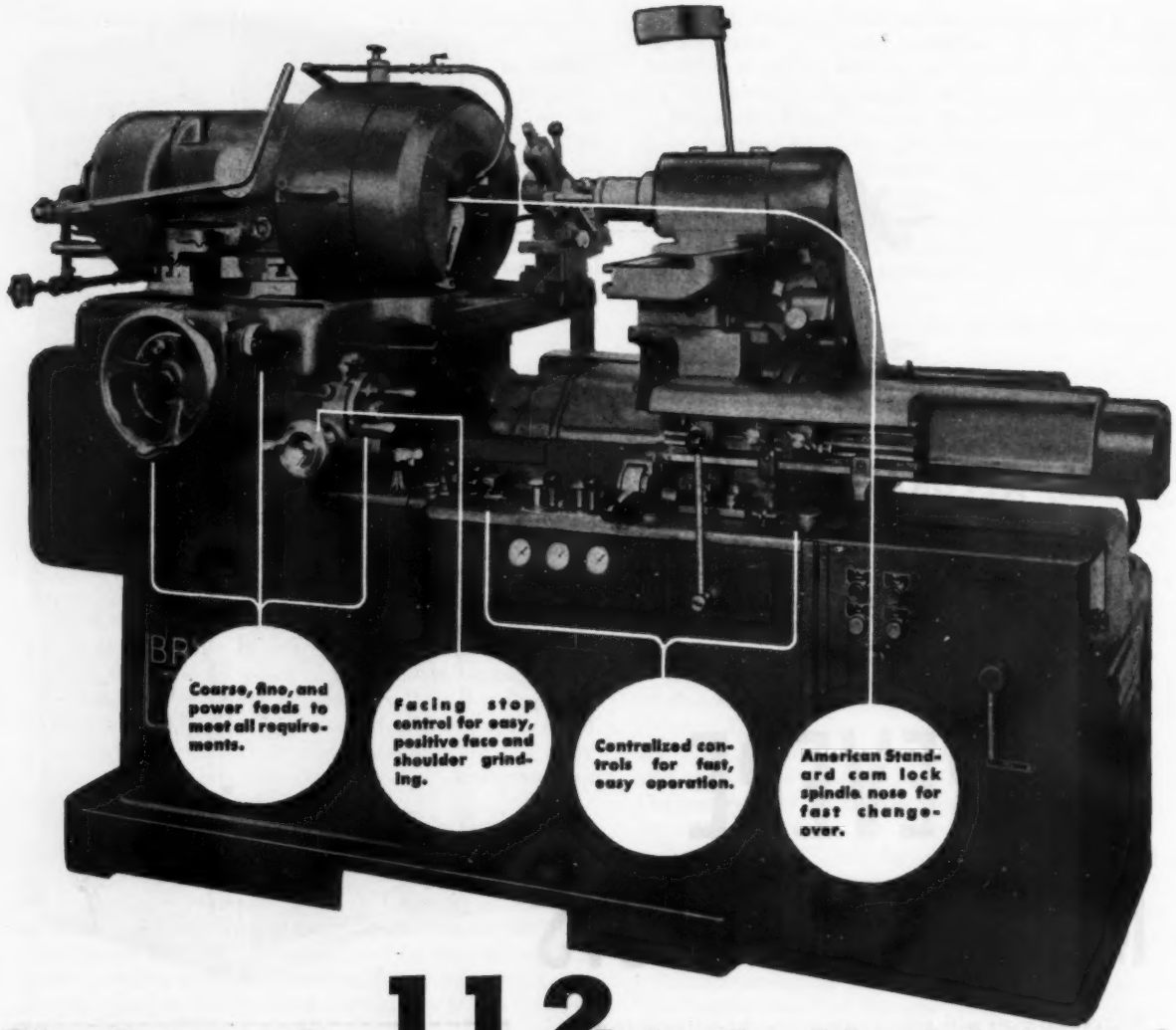
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American Standard cam lock spindle nose for fast change-over.

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INTER-OFFICE MEMO

To: Harry A. Ehle, Vice-pres., Sales

Date: 4/20/46

Production capacity on all types and ranges of All-Metal Rheostats has now been increased to provide additional production for scheduling during last week of May and following months, as per your request of 2/20/46.

From: O. J. Greenway, Works Manager

IRC

All Metal RHEOSTATS

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PR-50

PRT (AN3155)

TYPE PR-25—25-watt rating. Temperature rise, 140°C. Standard resistance values, 1 ohm to 5,000 ohms. Diameter, 1 31/32". Depth behind panel, 31/64".

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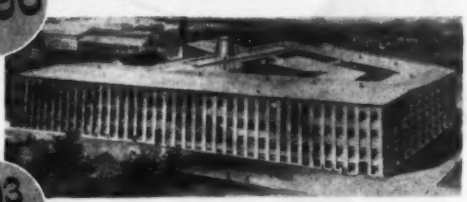

Primary reason is that there is no deadening monotony, no rut in work or outlook, in the daily operations at Taft-Peirce. Here, the horizon embraces all industry. Diversification, exploration, and original thinking are the prime movers of this business.

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Through these resources, you can draw on a practical working knowledge of production problems ranging from food to fabrics, from machine tools to machine guns, from chemicals to communications. No job is too large, none is too small. If it would help *you* to unload some, or all, of your new-product problems on the shoulders of this young-minded, fast-moving organization, you are invited to write to The Taft-Peirce Mfg. Co., Woonsocket, R. I.

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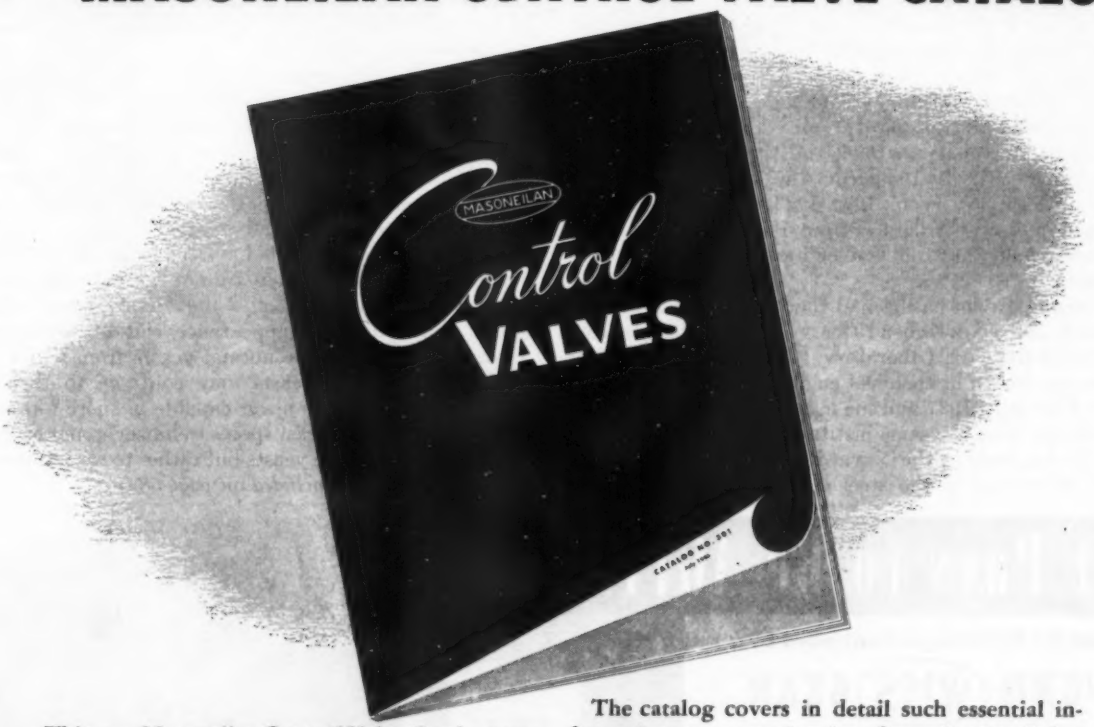

This new Masoneilan Control Valve Catalog contains complete factual information and covers every phase of control valve selection including C_v . . . Valve Flow Coefficient . . . which is a basic means for comparing flow capacities and characteristics.

The catalog covers in detail such essential information as control valve flow characteristics, flow coefficient and flow curves, materials and construction, selection of types, handwheels, dimensions, weights and other specification data. Write for your copy of this important catalog today.

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THE INSTITUTE GAZETTE

(*Concluded from page 576*)

ernment services during the war for rapid, high-quality production of materials and devices demonstrated the need for a fundamental re-examination of material processing techniques such as casting, welding, brazing and forging. Research and development during the war revealed promising avenues for future research in a field of fundamental importance to almost every branch of industry."

Professor Wulff joined the staff of the Institute in 1931 as an instructor and until his new appointment was associate professor of metallurgy. He was awarded the degree of engineer of mines from the Colorado School of Mines in 1924, the master of science degree in metallurgy from Yale University in 1926, and the doctor of science degree in Physics in 1929 from the University of Tuebingen, Germany. From 1925–1926, he was a Sterling teaching fellow at Yale and from 1929–1931 a National Research fellow at the Universities of Tuebingen and Munich.

Professor Taylor has been at the Institute as a research associate since November 1945, on leave-of-absence from the Naval Research Laboratory. He received his bachelor of science degree in chemical engineering from Michigan State College in 1937 and his master of science degree in metallurgy from the same institution in 1938. Since June 1937 he has been at the Naval Research Laboratory and since 1939 head of the steel castings section.

THE TREND OF AFFAIRS

(*Continued from page 552*)

of parent yeasts, and then, after growing for a while, separate and become discrete individuals. Some yeast genera, such as the *Torulopsis* that received so much attention during the war because of the British program to cultivate *Torulopsis* yeasts as human food, are able to multiply only by budding. But the majority of the commercially useful yeasts, all members of the genus *Saccharomyces*, are also capable of multiplying by means of spores, structures that may be compared very roughly to the seeds of higher plants.

During the formation of spores in the *Saccharomyces* yeasts, the intracellular structures that are the vehicles of heredity, called "genes," divide into two sets, that may be designated arbitrarily as *A* and *B*. Each spore receives only one of these sets of genes, so that an individual spore carries either the *A* set or the *B* set, but never both. Spores may germinate and produce viable individuals, but since such individuals have only half of the normal complement of genes, they are not normal cells, but are instead a special phase called the "haplophase." Haplophase yeasts differ in appearance and in physiological characteristics from the normal yeasts from which they derive. Haplophase yeasts may continue to thrive by budding, but they are never capable of spore formation.

The usual fate of yeast spores is, however, not to germinate into haplophase yeasts but rather to recombine with

(*Concluded on page 584*)

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When the Agitating is Controlled by a

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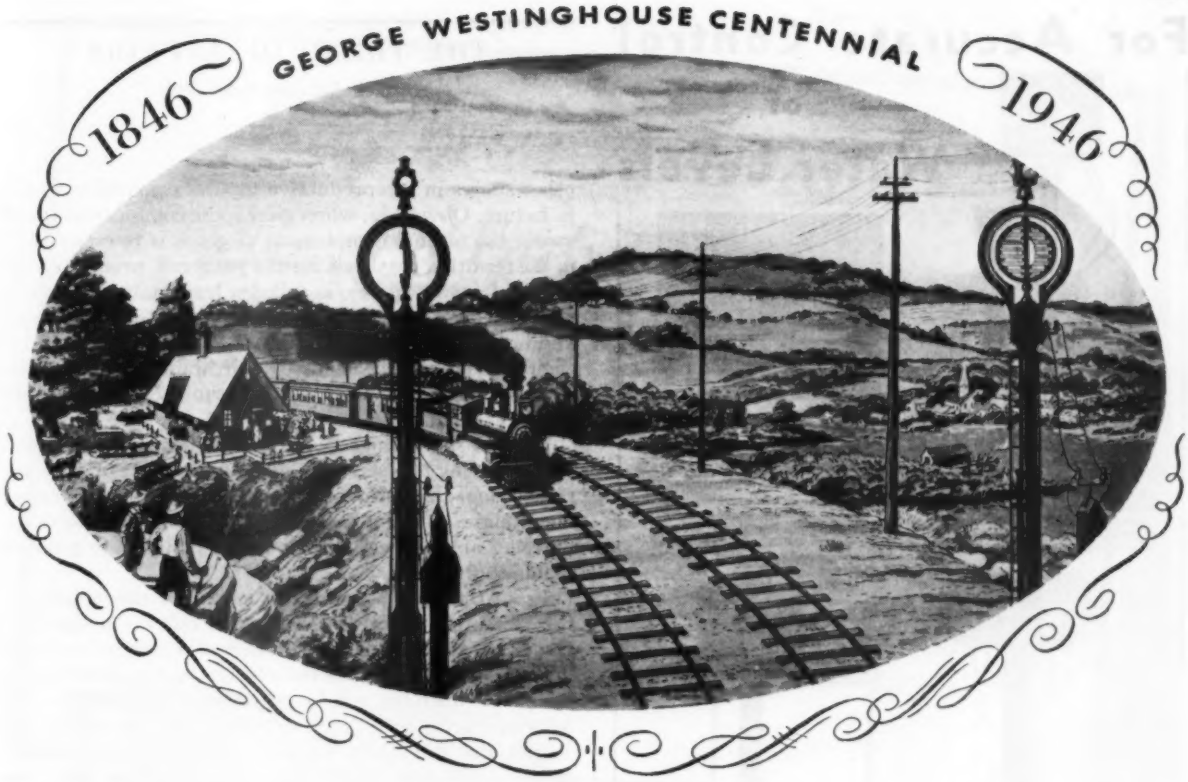

Semaphores *of* Safety

Although world-famous as the inventor of the railway air brake, few people realize that George Westinghouse also pioneered the *first automatic block-signaling system* for railroads.

While developing the air brake, Westinghouse clearly foresaw the need for improved railway traffic controls—to meet the demand for *greater speed and safety* in our rapidly expanding transportation systems.

In those early days, switches and signals were moved by hand. But, in such manually controlled devices, too much depended on the human element. A watchman might fall asleep—or become ill. Or some other mishap might break the human links in the chain and lead to disaster.

In 1881, George Westinghouse began to apply his brilliant inventive genius to the problem of power signaling and interlocking. As one scientist expressed it, "he used compressed air for the heavy work, electricity to pull the trigger."

And the same basic principles of railway signaling, developed by Westinghouse more than 50 years ago, *still serve in controlling our vast railroad networks of today!*

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TODAY—The Westinghouse Electric Corporation is providing *semaphores of safety* in yet another field—marine transportation. Recently, Westinghouse engineers equipped an Old Bay Line steamship with a *radar navigational aid* . . . to guide it safely through fog and dark of night. Now the S.S. "City of Richmond" makes its nightly run between Baltimore and Norfolk—*safely* and *free from delays* due to bad weather. Similar Westinghouse radar installations are now planned for use on inland waterway, coastal and ocean-going craft.

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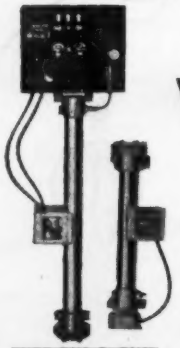

TYPE PW & PWD CONTROLS for Hydro-Pneumatic (Pressure) Tanks

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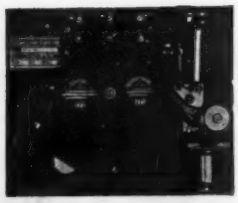
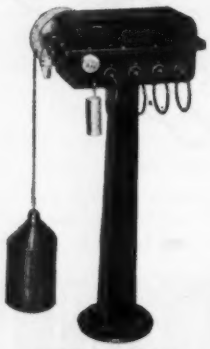


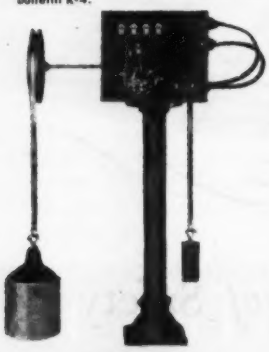
TYPE "A" ROTO-TROL Electric Surge Snubber Ball Bearing Construction Springless Mechanism

Permits accurate dependable control of level in distantly located elevated tanks. Available for single or multi-pump control. Unlimited differential between high and low setting. Write for Bulletin R-4.



MULTI-POSITION PROGRAMMING FLOAT CONTROL

For complex control of multi-pump installation. Any desired number of starting and stopping positions for each pump. SPLASH PROOF CONSTRUCTION MERCURY TUBE SWITCHES. Write for Bulletin 940.



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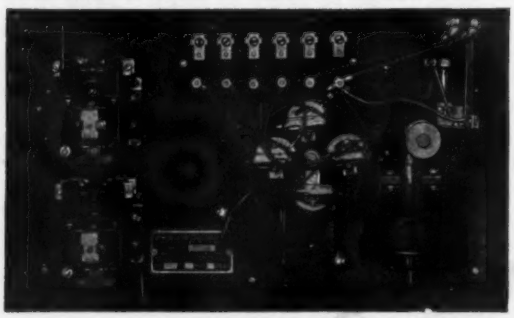
For control of any number of pumps, any sequence of operation. Moisture and corrosion proof construction. Indicating dial and pedestal for conduit connection optional. Write for Bulletin RF-2.



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(Pressure Type) for use with compression pipe suspended in sump. Time delay device prevents water-logging of pipe—no working parts in sump. Write for Bulletin RS-3.

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ELECTRIC ALTO-TROL for 2, 3 or more pumps.

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Elevated Tank Controls — **Automatic Alternators**
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D. W. C. RUFF '07, *Treasurer*

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THE TREND OF AFFAIRS

(*Concluded from page 582*)

other spores in a reproductive process essentially sexual in nature. Obviously, when an *A* spore combines with a *B* spore, the normal complement of genes is re-established in the resulting yeast cell. Such a yeast cell, product of the union of unlike spores, is called a legitimate yeast. The fact that legitimate yeasts are normal in every respect, and have their full complement of genes, is borne out by their normal appearance and their ability to repeat the cycle of spore formation, spore germination, and spore union.

But *like* spores may also unite, producing a yeast individual having two sets of *A* genes or two sets of *B* genes, rather than the normal *A* plus *B*. Such a yeast is called illegitimate. Its abnormality is attested not only by a differing appearance but also by an inability to produce viable spores.

From the standpoint of the industrial microbiologist, the prime characteristic of a useful culture is stability. Once the microbiologist has selected a culture as being able to produce the desired change in the substrate in which the microbes will be grown on a commercial scale, he wants to be sure that the culture will continue to act in just this way. Now we may understand that illegitimate yeasts are prized industrially because they are entirely stable. Since illegitimate yeasts cannot produce viable spores, they can reproduce only by budding, and budding can yield only an exact duplicate of the parent cell. In contrast, legitimate yeasts can, as shown above, yield three different types of descendants, first, germinated spores or haplophase yeasts, second, yeasts resulting from legitimate union of spores and third, a variation of the second kind due to mutations. Legitimate yeasts are subject to mutations, or spontaneous changes in hereditary characteristics, whereas illegitimate yeasts are relatively immune to mutations. Hence we obtain the third type of descendent, referred to above.

These advances in yeast genetics have placed on a more rational basis the maintenance of pure yeast cultures, which in the past was often done empirically. In addition, industrially valuable illegitimate yeasts may now be produced at will by preparing cultures of spores bearing like genes and stimulating union of such spores. Finally, the explanation offered by these findings for the instability of legitimate yeasts exposes a basic fallacy in traditional methods for establishing pure yeast cultures. These methods have been based on the isolation of a single yeast cell to serve as parent for a culture; such isolation was done either by dilution or by application of ingenious micromanipulators capable of picking up a single tiny yeast from the field of the microscope. But, as we have seen, if the yeast cell so chosen happened to be a legitimate individual, this single yeast could produce descendants of three differing types and might therefore give rise to a mixed and unstable culture. On the other hand, if spores are isolated, they may be forced to unite with others of their kind to produce the valuable illegitimate strains of yeast. It becomes apparent, therefore, that the true biological unit in isolation of pure yeast cultures is not the vegetative cell, but the spore.

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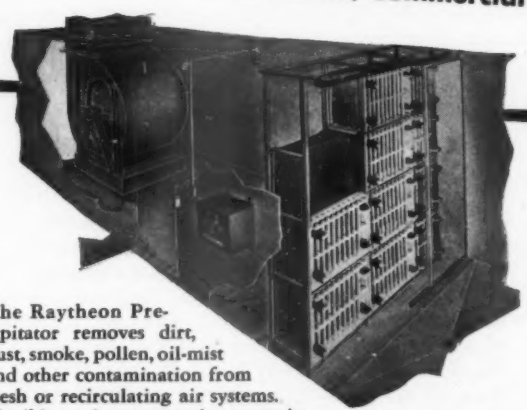

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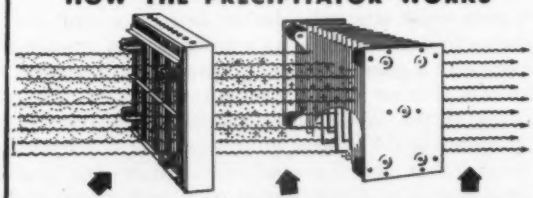

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SCIENCE, STRENGTH AND STABILITY

(*Continued from page 556*)

I do not judge, I do not evaluate the issues in question, but I do point out to you that we have within the month seen this whole mighty nation brought to the very verge of impotence and frustration by the extreme direct action of a single small group in its population. Enthusiasts for direct action on whatever issue must remember this, and must balance possible ill effects against the supposed worth of speed — if indeed direct action really does produce speed.

Science as a profession has not of course yet reached its answer to the dilemma; it is in the process of doing so. Some scientists, some engineers, have turned to direct action involving at times the extreme techniques and tactics of the pressure group, conscious, one hopes, of the hazard they run of becoming ex-scientists, ex-engineers, as a result. It is too early yet to judge of their effectiveness. Some scientists, as witness those in the Board of Consultants who drew the notable state paper known as the Lilienthal report, have ably collaborated as professional men in laying bases for public policy, thus engaging in tempered direct action within the frame of government. Many — I believe all — other scientists and engineers who are as yet undecided are searching their minds as never before, in the sincere effort to determine what their duty is and how best to perform it.

So we are brought back to the position of the sage who, in his insistence on definition and clear statement, was indeed the forerunner of the rigor and the discipline which we as scientists and engineers must strive for — back to Socrates, and to his declaration that an unexamined life is not worth living. Though in this swift-paced age the time is short, I welcome the fact that this is so, that the occasion for true analysis is on us, for I am sure that the end result cannot but be good. Thus far, I have spoken of science, and professions, and the professional man's dilemma, almost entirely in terms of the United States. Now let me go beyond that, for the full implications of the question, as concerns science, extend beyond national boundaries even though a sound solution of it will mean the greatest good at home.

In the self-scrutiny to which we are brought by the inescapable force of events, scientists and engineers possess more immediately than any other professional group, two very great strengths. In the first place, our professional activities enrich us as a group with a greater frequency and a greater range of contact and collaboration with men of other nations than are enjoyed by other professions. In the second place, and more importantly, the very nature of the body of knowledge with which we deal knows neither time nor place, nor nations, nor peoples. Astronomer or zoologist, Briton or Yugoslav, rock-ribbed Republican or Communist, in the face of the elusive and eternal objective truths with which he deals, the man of science is simply that — a scientist. As a profession, then, we have common ground with men of all kinds and conditions — common ground that, in these days of the breath-takingly swift juxtaposition of races, creeds, cultures, and political philosophies, is of inestimable value as a means toward understanding and mutual confidence. Whatever

(*Concluded on page 588*)

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SCIENCE, STRENGTH AND STABILITY

(*Concluded from page 586*)

we do toward furthering meetings on that common ground, toward fortifying and confirming it as a starting point for other meetings by other men, is so much done toward the inculcation of collaboration and concord among the peoples of the earth.

Here is an ethical imperative such as no professional group before this time has had the privilege and the opportunity to meet. As here at home in the United States we examine into the standards of honesty and objectivity which science requires but which our profession has not yet brought together in a self-imposed and self-administered code of ethics, we shall accomplish two great ends. First, we shall clarify and confirm in our own minds what and why we are and how and why we can best share in the forming of the sound public opinion essential to strength and stability. Second, we shall chart the broad reaches of knowledge and determine the seamarks of sure intellectual and ethical principles which because they are common to us as scientists will, we know, be recognized by scientists everywhere as common to them also. So in the full stature of a matured profession men of science throughout the world can join in meeting the responsibility stemming from their ministry to the people and can do their full share in the formation of the enlightened world opinion which must be developed for peace among the nations to be assured.

INTERNATIONAL RELATIONS

(*Continued from page 564*)

A second essential step for the United States in the scientific age is to evolve a new degree of correlation between science and statecraft. One of our honored guests, Vannevar Bush, has recommended in his prophetic report "Science, the Endless Frontier" that the United States must have a National Research Foundation, a scientific reserve corps, and scientific attachés attached to missions overseas.

Indispensable as are these proposals, I believe that certain additional measures are equally necessary. The President's cabinet should at all times contain a scientist of highest repute to advise the President of the bearing of domestic and foreign scientific developments upon national policy. Only the presence of such an individual in the cabinet of the United States can assure that at every stage of policy making and execution the implications of science and technology will be duly considered. National existence may hinge upon a proper appraisal of these facts at any time. The creation of such a post does not necessarily mean the establishment of a National Department of Science. It is essential only that such an adviser be a full member of the body in a position to speak with such authority at all times and to all officers of government.

I would also suggest that there should be established a position of Assistant Secretary of State for Scientific

(*Continued on page 590*)

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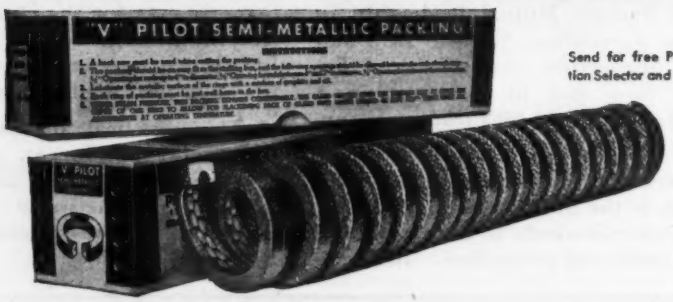

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INTERNATIONAL RELATIONS

(*Continued from page 588*)

Affairs in order that our foreign relations may be conducted in the light of a proper evaluation of our power at home and of events abroad. No system of consultants is an adequate substitute for a high ranking policy officer within the Department of State. Reports of scientific attachés attached to American missions abroad will not receive suitable attention unless there is someone to correlate them and to initiate the appropriate action in response thereto. Successful policy can be formulated only by due consideration of all factors involved and by constant association of those needed for this purpose.

A further suggestion which I would offer in this same connection would be that the United Nations Security Council should be provided with a Scientific Advisory Committee. The Atomic Energy Commission approved at the General Assembly in London last winter may be a step in the right direction if it can be made to operate more effectively than the Security Council and the Military Staff Committee have been able to function as yet, and if its jurisdiction may be more broadly defined. A United Nations strong enough to maintain peace and security in the scientific age should be equipped in its own right with machinery and knowledge which will enable it to act quickly, intelligently and effectively for the enforcement of the Charter.

There is something more to being a Great Power than merely possessing impressive size and military power. Greatness demands a sense of responsibility, trusteeship. The United States has achieved the leadership which it enjoys today in part because others have had confidence in it born of past deeds of unselfishness, of generosity, of respect for the weak, and promotion of a better life among all peoples. These virtues it must keep and cultivate in the scientific age.

And so in facing the technology of international peace we are brought back to the proposition that as the developments in science and engineering depend upon the mind of man, so also the issues of peaceful growth or of disastrous conflict among the nations revolve about the concepts and actions of fallible men.

In an address prepared for delivery on an occasion which occurred after his death President Roosevelt observed that "if civilization is to survive, we must cultivate the science of human relations, the ability of all peoples of all kinds to live and to work together in the same world at peace." If, as Francis Bacon believed, science, if given a suitable opportunity, can enlarge the "bounds of human empire to the effecting of all things possible," we must return to the basic thought of Alexander Pope — "the proper study of mankind is man."

The accomplishments of man in civilizing entire continents, in bridging the oceans, in harnessing the energy of the atom and in obtaining agreement among 50 nations for an organization for peace and security afford room for hope that if the scientists and the statesman concert their endeavors, a better world and a more abundant life can be attained in the scientific age.

The problems involved in the relationship between technology and international peace, which have been

(*Concluded on page 592*)

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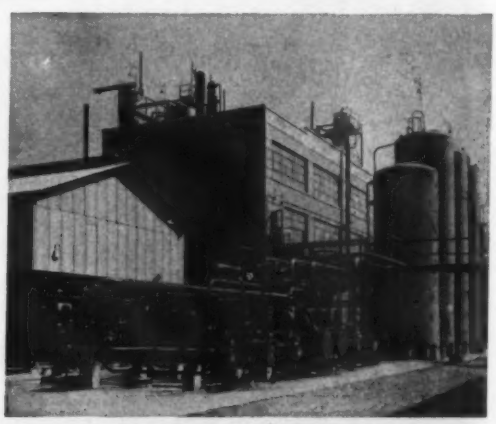

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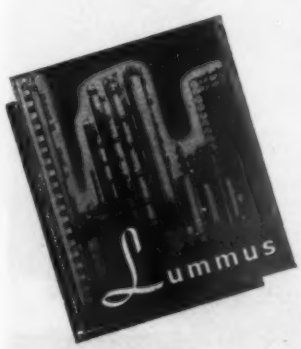

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INTERNATIONAL RELATIONS

(*Concluded from page 590*)

touched upon here only by way of example, demonstrate that a study of the fundamentals of international relations has become an essential part of the education of the engineer in the scientific age, for the engineer functions in a human as well as in a material world. The complexities of international affairs can no more be measured or dealt with properly by rule-of-thumb methods than can the construction of bridges, the production of synthetic fabrics, or the development of electronics.

The time has come for the scientist to pioneer on the frontiers of human relations. To fight a war, Oliver Wendell Holmes once said, "You must believe in something and want something with all your might. So you must do to carry anything to an end worth reaching." More than that one must be willing, said Holmes, to commit one's self "to a course, perhaps a long hard one, without being able to foresee exactly where you will come out." So it must be in "The Technology of International Peace."

MAIL RETURNS

(*Concluded from page 536*)

No matter how many honors one may receive it still gives a good big thrill to see one's work reproduced on the cover of a well known magazine. I assure you I enjoy it and also appreciate the compliment you pay me.

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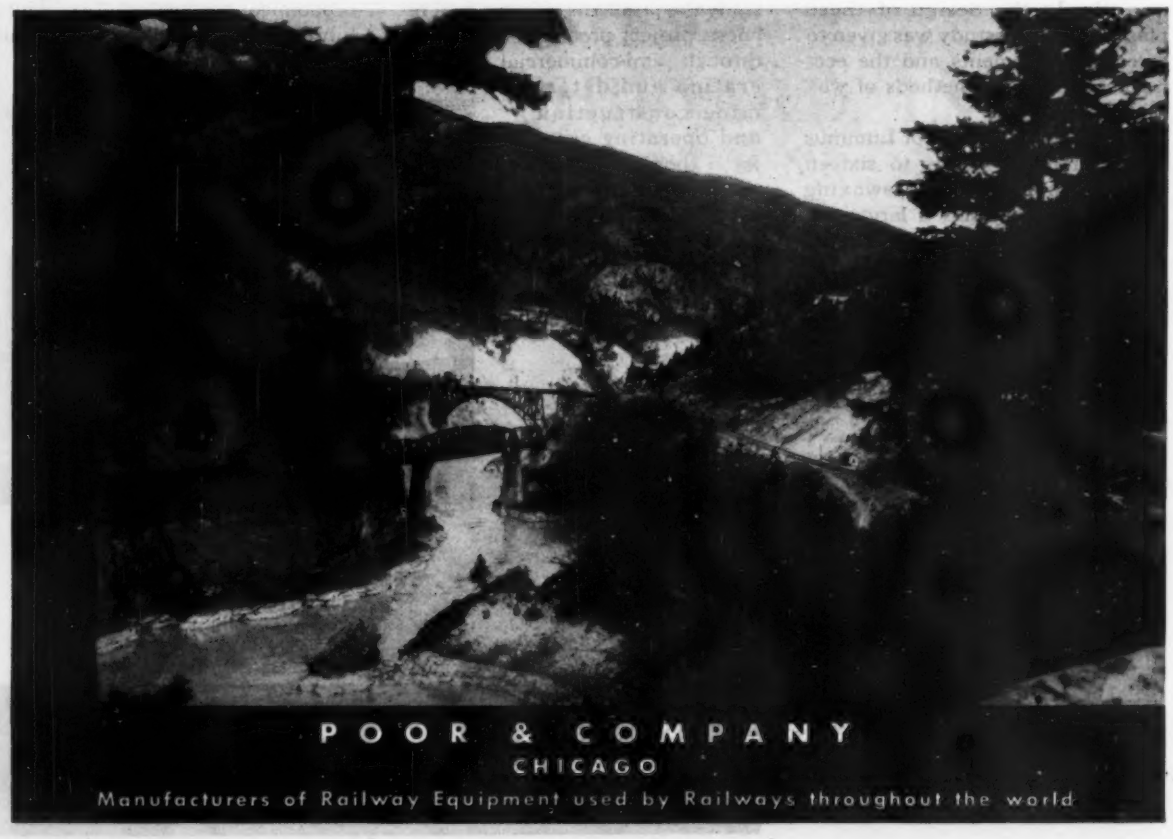

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LOOKING AHEAD AFTER 50 YEARS

(*Continued from page 566*)

outlined the natural laws governing the production of wealth. I can see him now, standing before us in Huntington Hall, emphasizing the difference between the law of supply and desire and the law of supply and demand. He said, "Remember that the desires of people will always exceed the supply, but the demand results only when they are willing and able to pay for the things desired."

It seems as though some of the truths these men taught us hold the key to the remedy of today's troubles. Do not many of today's international and domestic troubles come from failing to realize these truths?

Mass production through concentration of capital and subdivision of labor rapidly increased productivity, lowered costs, and increased the average standard of living. In many instances, however, it gave undue power to wealth. This power was abused and the bargaining power of the individual was reduced. Many laws have been passed to prevent monopoly and curb those selfish abuses. Laws for collective bargaining by labor have been encouraged to equalize individual opportunity and to protect public welfare.

The labor of the hand can produce a certain amount of product. When to this is added the labor of the head in applying the tools of industry and the fruits of scientific research, the production will be increased a thousand fold. But only when a man's heart is also in his work will the ultimate goal be reached. This can come only when he, as an individual, is protected in his life, liberty, and the pursuit of happiness. Today such world foundations of tranquility are threatened by the forces of selfishness, by the lust for power by those who would place might before right.

In government, as in industry, there exists the old contest between monopoly and competition. The problem to be solved is whether the state shall be all powerful and master of the people or whether the freedom of the individual shall be preserved, with the state becoming the people's servant.

In these days of mass production in industry, only through coöperation among — rather than by antagonism between — those who furnish the labor and those who furnish the tools of industry, can the present standard of living be maintained or improved. We come nearest to the ideal condition whenever an individual is free to choose his own employer and the employer is free to choose his employees; when there is plenty of competition and government of the people acts to uphold the principles expressed in the Declaration of Independence and in the Constitution. The individual achieves independence and ability to bargain for his services when he controls the freedom of his labor and the necessary tools and knowledge to apply it. Whenever there is a monopoly in the control of capital, or a monopoly in the control of labor, individual freedom is threatened.

In modern times the growth of mass production has resulted in the concentration of wealth in the hands of a relatively small number of people and an approach toward monopoly. Many abuses of the power of wealth followed, each of which tended to reduce the freedom and

(*Continued on page 598*)

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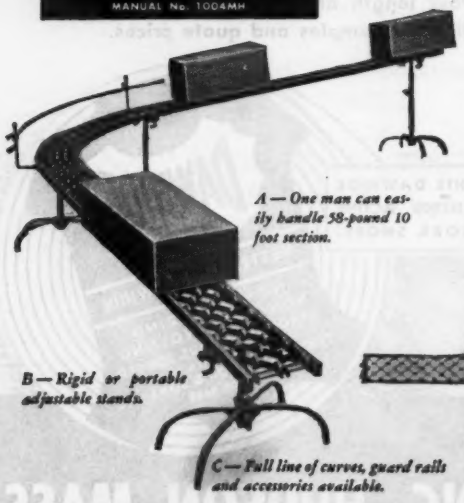

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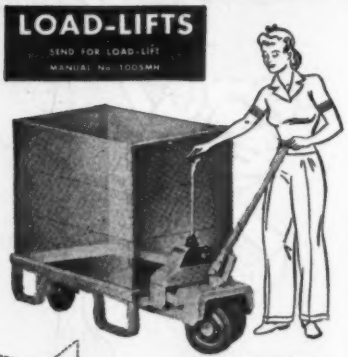

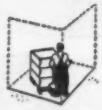

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DURING the recent drama-packed years of war, the precepts of freedom and liberty were ever foremost in our thoughts. To guard and preserve them for us, men gave their lives. Precious indeed are the rights and privileges that are ours in a free, democratic society.

In times of peace, it is our continued responsibility to guard against any relaxation of vigilance toward insidious encroachments of those liberties we cherish. Eternal vigilance is the price of liberty.

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IS STILL A CRAFT

LOOKING AHEAD AFTER 50 YEARS

(*Continued from page 596*)

bargaining power of the individual. This condition necessarily resulted in a series of laws to curb the power of capital and to prevent its use for selfish purposes rather than for services of the many.

Through legislation and taxation the power of capital has now become so restrained as almost to destroy the incentive to risk putting capital to constructive use. The result has been that government has supplied capital rather than private interests.

More recently laws aimed to restore the bargaining power of the individual have gone to the opposite extreme and have resulted in monopolistic practices in the control of labor, especially since the close of the recent war. These practices have gone so far as to paralyze national production and transportation and have caused the government to take control of the tools of industry and transportation, thus concentrating control of all wealth in the hands of the government.

Many laws passed to strengthen the bargaining power of labor have failed to provide the proper safeguards to make labor responsible for its actions. In recent years this has been true to such an extent that the control of labor has been concentrated in fewer hands than was ever the case before. With increased power, monopolistic practices grew up in the control of labor which have resulted in abuses similar to those formerly practiced by capital. The old, selfish "public be damned" attitude, originally espoused by a misguided capitalist, has recently been

(*Concluded on page 600*)

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LOOKING AHEAD AFTER 50 YEARS

(*Concluded from page 598*)

applied by labor leaders with wide and distressing effects. This is a natural result when one class tries to gain a selfish advantage at the expense of the people as a whole. The processes of bargaining have been distorted to such an extent as to require government to take over the control of capital to carry on the bargaining in order to protect the public.

The end result of a continuation of this trend would be an all-powerful state with the individual subject to the whim and planning of a dictator. Should this happen, the individual bargaining power of both capital and labor would be completely destroyed.

The recent war was caused by the selfish ambition of the leadership of one nation to dominate other nations. At the outset attempts were made to maintain peace through a policy of appeasement. After appeasement failed, the war which followed called for the most destructive forces in history to prevent an Axis victory. Millions of lives were sacrificed to bring back peace and security.

The American principles of government were conceived and developed so that the individual would be free and have opportunity to advance through merit. These ideals can best be preserved when no class is favored unfairly and when wealth is distributed as widely as possible in the hands of individual citizens who have created it. Our Constitution provides us with a pattern for the attainment of this state. It has set an example which many other peoples, freed from oppression, have copied.

Now air power and the development of high speed communication have made the world one unit. The fundamental principles of our Constitution applied to all nations, and carried out as intended by our forefathers and practiced for a century and a half, offer the most successful formula for a world of peace and progress.

A similar restoration of the balance of power in industry between capital and labor offers the same opportunity for peace and progress within the nation.

The longer abuses of power are tolerated, the more difficult it is to apply corrective measures. Appeasement and temporary measures of expediency will not prove successful in solving the international problems of clashing ideologies, nor will it correct the condition within our country where people are divided into classes and engaged in industrial strife. The cause must be removed by curbing the forces of selfishness whether applied by a nation or by an economic group within a nation.

The results of the advances in engineering, research, and technology, which can now be applied to our economy can make the world of tomorrow one of greater opportunity than we have ever known. The increase in knowledge and power can also be used for destructive purposes. If there is lack of vigilance, one nation can now become powerful enough to conquer all the world quickly.

It is the desire of all men to be free and to get along in peace and harmony with their neighbors and to make the earth a better place in which to live. Whenever justice and right are challenged by the selfish powers of might, appeasement has given way to a fight for principle — and this is the price we must be able and willing to pay if we are to transform our desire for peace and freedom into demand.

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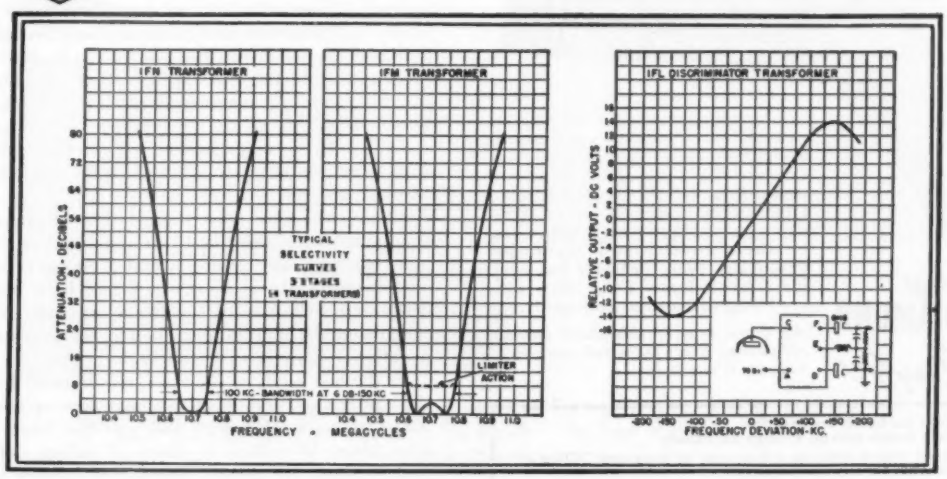

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ALUMNI DAY — JUNE 1946

(*Continued from page 572*)

These buildings are: a library, designed to serve as the chief cultural center of the Institute; a dormitory, housing about 200 students and planned for use as a Senior House; a combined hydraulic laboratory and naval towing tank; a machine tool laboratory to house the fine new set of machine tools recently acquired to replace the old tools, most of which were relics of World War I; a gas turbine laboratory closely associated with the Sloan Automotive Laboratory; a large laboratory for nuclear science and engineering; and a gymnasium unit.

In addition to these new buildings, we are taking two temporary steps to provide emergency housing for students during the period of the "veterans' bulge." Building 22, a temporary building erected during the war to house part of the activities of the Radiation Laboratory and originally scheduled to be torn down in July 1946, will be converted into a temporary dormitory which can house 500 students in reasonable comfort. Also we have applied to Veterans' Housing Administration for veterans' housing to accommodate 235 families of married students. This application has been approved, although the definite housing has not as yet been assigned. These houses can be put up rapidly and we hope to have them available by the time we reach our peak of enrollment next winter.

Assigned second priority and not yet approved by the Executive Committee are a faculty club and a new biology laboratory. Both of these will be very great assets to the Institute and should be made the next objectives as additions to our physical plant. As yet there are no funds in hand for either project.

To make the record of new facilities complete, I should include also the steps which have already been completed to our very great advantage. We have acquired for special research use the Hood Building near the Institute on Massachusetts Avenue. It was converted during the war into an excellent permanent laboratory building. A few months ago we moved into our new Chemical Engineering Laboratories which had been constructed during the war and operated by the Chemical Warfare Service. These laboratories were built at our expense and to our own design, following a very careful study by our Corporation's Visiting Committee and staff of the Chemical Engineering Department. We have also moved into Building 20, the fine new permanent building erected during the war for the Radiation Laboratory and into which the Institute put the funds needed in excess of those supplied by the government which would have erected equivalent temporary quarters. We have also moved a number of our activities, notably those associated with electronics and acoustics, into the largest and best of the temporary buildings erected during the war for the Radiation Laboratory.

At our own expense we have erected 100 houses for married veterans, which form a very attractive little community named Westgate Village on the western part of our property. These are now fully occupied and giving excellent satisfaction. They have been the envy of all associated with various veterans' housing projects.

Finally, we have done a great deal of remodeling and re-equipping in the older Institute buildings, of which the major item has been an expansion and a complete re-equipment of our chemical laboratories, which had been our bottleneck in determining the size of the freshman class and in which the chemical desks and plumbing had badly deteriorated since their installation back in 1916 and 1917.

In the last analysis the basic requirement for implementing these programs is money. Costs have gone up and are still rising. Although our endowment and invested funds have increased from about 30 million to about 47 million dollars during the past 16 years, the greatly depreciated interest rates have actually reduced our over-all income from investments.

These factors create an exceedingly difficult situation. We have been able to meet it and to embark upon future plans with

(*Concluded on page 604*)

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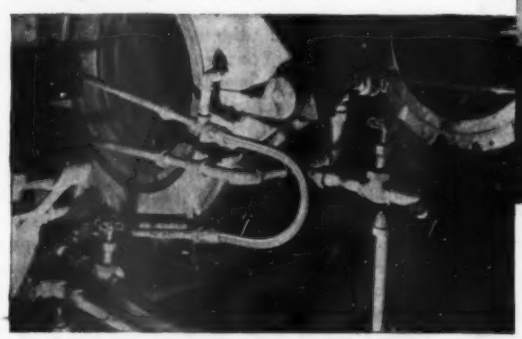

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ALUMNI DAY — JUNE 1946

(*Concluded from page 602*)

some assurance only because of two factors: the generous financial aid which has been given us by individuals, foundations and industrial companies; and the research and educational contracts from Army, Navy, other government agencies, and industry. It is largely through this latter type of assistance that we are now operating on a peacetime budget approximately double the largest pre-war budget of the Institute. This gives us a great opportunity; at the same time it does involve a very real risk as to continuity because these outside sources of funds can be guaranteed usually for only a year or two ahead, and there is always the possibility that a change in government policy or in the general prosperity of the country may result in their very substantial reduction. The present trend, however, is in the direction of an increase rather than a decrease in these outside sources of support, and in the extent to which the Institute is asked to cooperate in excellent educational or research programs of this sponsored type.

I know that you will be interested and gratified, as I am, in knowing the extent of direct contributions, not involving any contractual obligations, but coming as outright gifts or grants to the Institute for its general or special purposes. During the past eleven months of our current fiscal year these gifts and grants total $2,456,963. This eleven months' total already exceeds the largest figure for total gifts in any twelve-month period in the last twenty years, and only three times in the entire history of M.I.T. has this figure for annual gifts been exceeded. These times were when George Eastman made his three principal gifts.

Of the total gifts thus far this year, almost exactly $1,500,000 came as gifts from industrial companies, about $180,000 came as grants from foundations, and about $780,000 represent gifts from individuals. Of special note is the approximately $150,000 received as net contributions to the Alumni Fund in excess of the cost of operating the Alumni Association. This continues a gratifying record of continuous growth since the inception of this Fund. A continued income of this magnitude is equivalent to capital investment of four or five million dollars. It is a pleasure to report that the next year's Alumni Fund has started off at record-breaking pace.

In his address on this occasion just a year ago, Gerard Swope pointed out that the Alumni Fund gifts, helpful and encouraging as they are, probably represent only about 0.06 of one per cent of the total income of our alumni. When looked upon in this manner the results are not so impressive, and suggest that many of our alumni may view the Alumni Fund as just another one of those worthy causes among which they distribute their benefactions. In terms of tithe, so customary in contributions to the church, and the 15 per cent deductible recognized in taxes, and the ordinary percentage given to worthy causes by good citizens generally, I believe that this Alumni Fund figure should and can be very substantially raised, by the simple process of suggesting to our alumni that the importance of M.I.T.'s work justifies them in giving this Fund a higher priority in their list of contributions. In fact, the M.I.T. Club of Chicago has set for its goal an increase from 0.06 of one per cent to 0.5 of one per cent of income, and hopes that other alumni groups may follow suit.

In conclusion, may I simply say that the opportunities in the era ahead for this institution are very great and of exceeding interest. It will require the most effective, loyal, and generous cooperation of every alumnus and friend of M.I.T. to bring these opportunities to effective realization. I believe that we are now in an exceedingly critical period because our actions now will set the pattern for the new era ahead. We are anxious that this pattern be drawn with vision and courage, and appeal to every alumnus and friend of this institution and to every one who really believes in the value of its objectives and accomplishment to make a special effort to help us in bringing the various plans which I have described to full fruition.

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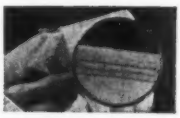

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APPLICATIONS OF SCIENCE TO FOOD

(*Continued from page 560*)

of this asset, as well as of the scarcity of land suitable for pineapple cultivation, we have become staunch supporters of the Federal Soil Conservation Service. The magnitude of our program is such that we maintain our own Soil Conservation Service.

Mile after mile of gently undulating terraced plantings now cover the mountain slopes of Oahu and Lanai and soil conservation practices begun in 1939 have now been applied to more than two-thirds of our plantation areas. At a cost of approximately $350,000 we have already completed the installation of 1200 miles of terraces and the construction of accessory diversion ditches and dams. The field layouts are designed to channel the heavy rains into slowly flowing rivulets, conserving at one time both the invaluable top soil and the badly needed moisture.

In only the old ratoon fields, awaiting incorporation in the soil conservation program, do we find the rigidly perfect pattern of straight rows and intersecting roads. These fields provide a sharp contrast, visually and functionally, to the new techniques. Under this old method of planting there is an easy channel for prompt drainage, but unfortunately this is attained at a cost of irreplaceable top soil. In the first 40 years of intensive cultivation considerable damage was done to some of our lands.

It is our belief that contour planting will serve to enhance this primary asset — good land, suitably located. Many problems remain to be worked out in adapting mechanical operations to the new contour farming, but the results achieved so far are encouraging.

Farm mechanization has developed to a considerable degree in the Hawaiian Islands, particularly in the pineapple industry. Farm equipment manufacturers have constructed new types of farm machinery and, in addition, mechanical engineers engaged in agriculture have developed specialized machines to alleviate arduous field work and increase agricultural efficiency. The assortment is wide, running all the way from the familiar items of farm machinery to specially designed cultivators, harvesters, fertilizing machines, sprayers of weed killing and other chemicals, and a number of other machines.

Fertilizer was formerly applied by hand, with each application carefully placed at the base of the plant. The magnitude of this task may be illustrated by the fact that our company alone usually cultivates approximately 350,000,000 individual plants. Today fertilizer is almost entirely applied by machines specially constructed for that purpose, and the timing, kind, and quantity of fertilizer are all scientifically controlled from the running records of the plant physiologist who reports, from continuing analysis of the growing plants, their need for food.

Weeding by means of hand hoeing was one of the most difficult and time consuming of all plantation operations, and it is now largely taken care of by machine cultivation and the spraying of herbicides. Experiments are also being conducted in the use of flame cultivators for the eradication of weeds.

New types of tillage equipment are now in process of development which, in the event mulching with plants does not prove feasible, will facilitate reconstitution into the soil of the 125 tons of old plants per acre which are

(*Continued on page 608*)

William H. Coburn, '11 William F. Dean, '17

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APPLICATIONS OF SCIENCE TO FOOD

(*Continued from page 606*)

available as a soil component for the new crop of pineapples. The intensity of cropping of our soils rarely fails to attract the profound interest of both the professional and novice in farming. Scientific tests and practical experiments have indicated that our soils can remain in almost continuous production without a true fallow.

Contrary to the practices in many mainland areas, crop rotation is not employed. Pineapples follow pineapples year after year — cycle after cycle. In most areas our fields have shown no decline under this regimen. Instead, the majority of our areas have shown substantial increases in production.

Harvesting by machine has been one of the most difficult problems. Since the nature, size, planting patterns and other factors of the various types of crops are different, the matter of design has taxed the ingenuity of engineers. In the California lettuce industry this problem was solved by mechanical conveyors which transported lettuce from fields to trucks.

In harvesting pineapples it has been the practice for workers to pick and carry the fruit from fields to the roads where it was decrowned, graded and placed in boxes which were then loaded onto trucks. At the cannery the fruit was unloaded box by box. Such operations required a formidable amount of burdensome hand labor since the Islands produce in excess of half a million tons of pineapple a year. Furthermore, more than 70 per cent of this production is generally harvested during a 12-week summer period.

As a result of determined effort and trial with several models, a satisfactory harvesting machine has been developed by our company. Each of these machines will ride like a giant crab upon specially constructed trucks and from each of these 8,000 pound units a 50-foot conveyor will stretch out over the adjacent pineapple lines like an extended arm. Upon this conveyor as many as 200 pineapples per minute will be placed by the field workers who now will be freed from the extraneous burden of transportation and can give their full attention to the selection of fruit of the proper ripeness for picking. As each truckload of fruit is filled, the harvester mechanism will extend its hydraulically controlled legs straddling the trucks and elevate its body so that the full truck may move out from under it. It will rest in this position while the succeeding truck is placed in readiness to receive the conveyor and in its turn is ready to be filled with the ripened fruit. The bins are transported from fields by trucks and are unloaded mechanically at the cannery. Many other arduous farm jobs are now done by machine.

Waste in the processing of foods is a major concern of modern agriculture; such waste of food-yielding products in our country has been appalling. One example of how waste has been cut down in our industry is illustrated by the use of the ion exchange technique which previously had been used primarily for water purification. With the development of new synthetic resins, this technique has been experimented with as a means of refining both beet and cane sugar. In our own company we followed this

(*Concluded on page 610*)

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APPLICATIONS OF SCIENCE TO FOOD

(*Concluded from page 608*)

lead and we are now about to install ion exchange apparatus for the treatment of waste mill juices. By this method we can recover, from otherwise waste fluid, large quantities of natural sugars for canning syrups, as well as substantial additional amounts of valuable organic acids.

It is interesting to point out in passing that one result of this scientific approach to pineapple production is that pineapple, possessing quality nutritious properties and representing a high degree of consumer value among agricultural commodities, has become a staple in the diet of the consuming public in America.

Coverage of this subject would not be complete without directing attention to the need of educating people in the various parts of the world to the importance of maintaining a properly balanced diet. In Hawaii we have come face to face with this problem because most of the workers on our plantations are Japanese and Filipinos whose peculiar diets are generally known.

In an effort to improve general health conditions amongst rural plantation workers, carefully controlled experiments were conducted with different types of diets. The results obtained disclosed that the determining factor in a properly balanced diet was not whether the diet was starch (as had been taught in all schools) but whether the starch was in the form of an alkaline or acid residue type.

As was to be expected, the problem of educating these people concerning the value of a properly balanced diet was a real one. However, the improvement shown in general health conditions in these areas was most gratifying, but the most significant advances were made in preventing tooth decay and reducing infant mortality.

Considerable time would be required to cover this vital subject but it seems safe to conclude that on the basis of the studies conducted in Hawaii there is ample evidence to indicate that programs of this nature can accomplish much in improving health conditions throughout the world.

The progress in the technology of food production has been so rapid that its implications are as yet little understood. Food for the hungry is to be measured now, not so much in terms of areas of usable soil, as in terms of the degree to which scientific knowledge is applied in the use of that soil. The means are there, if properly utilized, to produce an abundance where scarcity existed before.

Let me emphasize in closing that the examples I have cited of the progress made in food technology by no means reflect complete satisfaction or complacency with the job done thus far. They serve only to illustrate the way to improvement and to fire our imagination in tackling the unfinished tasks that lie ahead. These developments and many more must be used in the future to chase from the world the spectre of hunger and the concomitant threat of war. Currently, we must share the responsibility of feeding exhausted nations, and tightening our own belts the while, if necessary. But our responsibility to our neighbors is more than the giving or selling of our plenty; it is to pass on the fruits of our science and technology and our research in order that they may stand on their own feet. A gift of scientific and technological knowledge is of far more lasting value than the gift of food itself.

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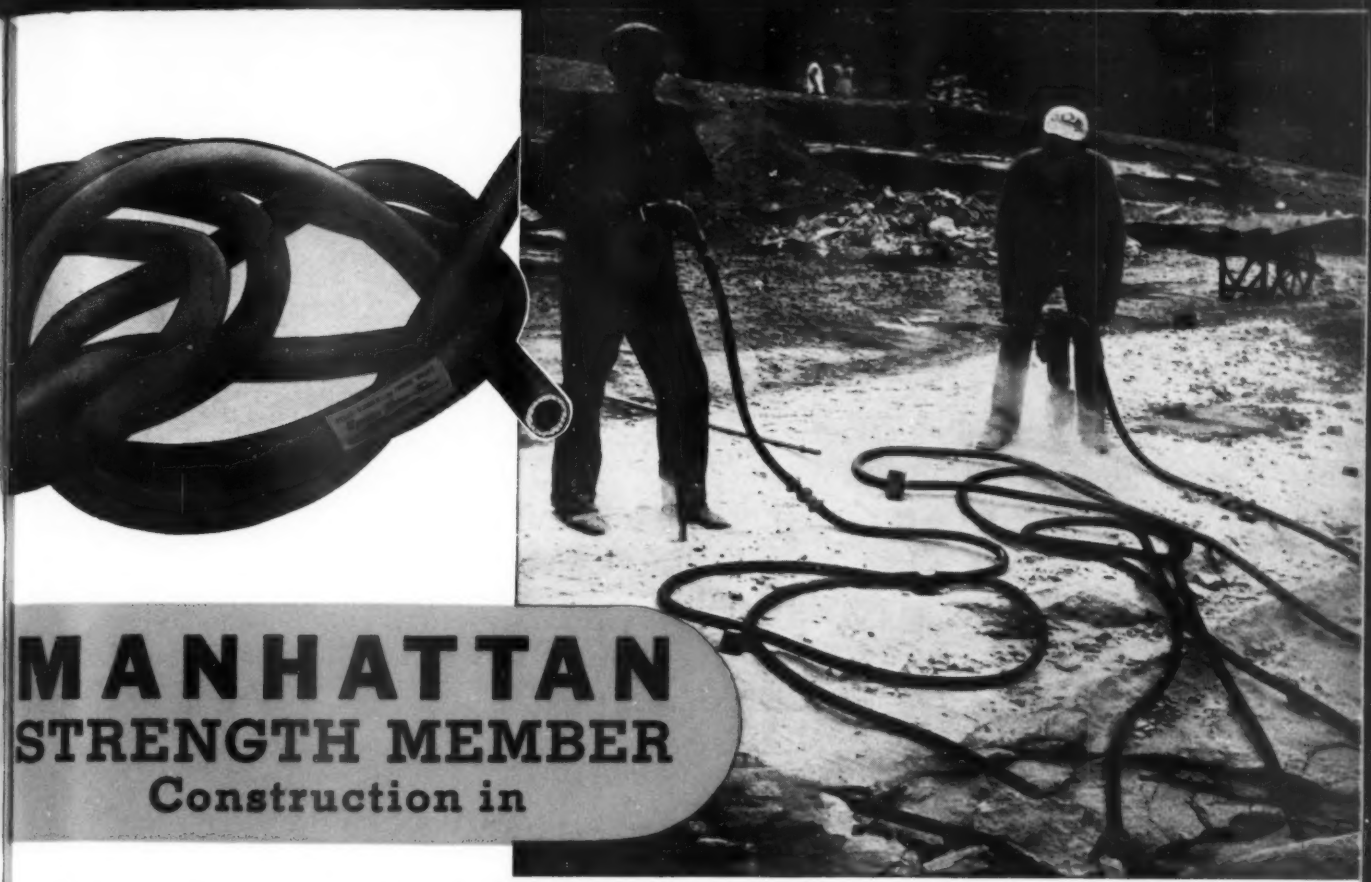

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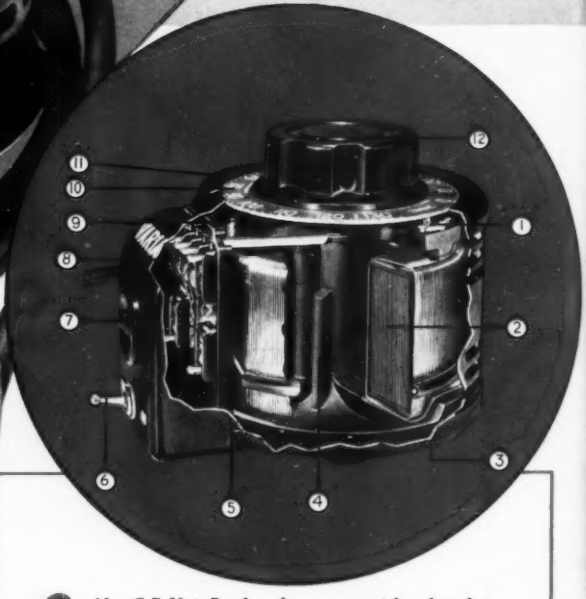

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